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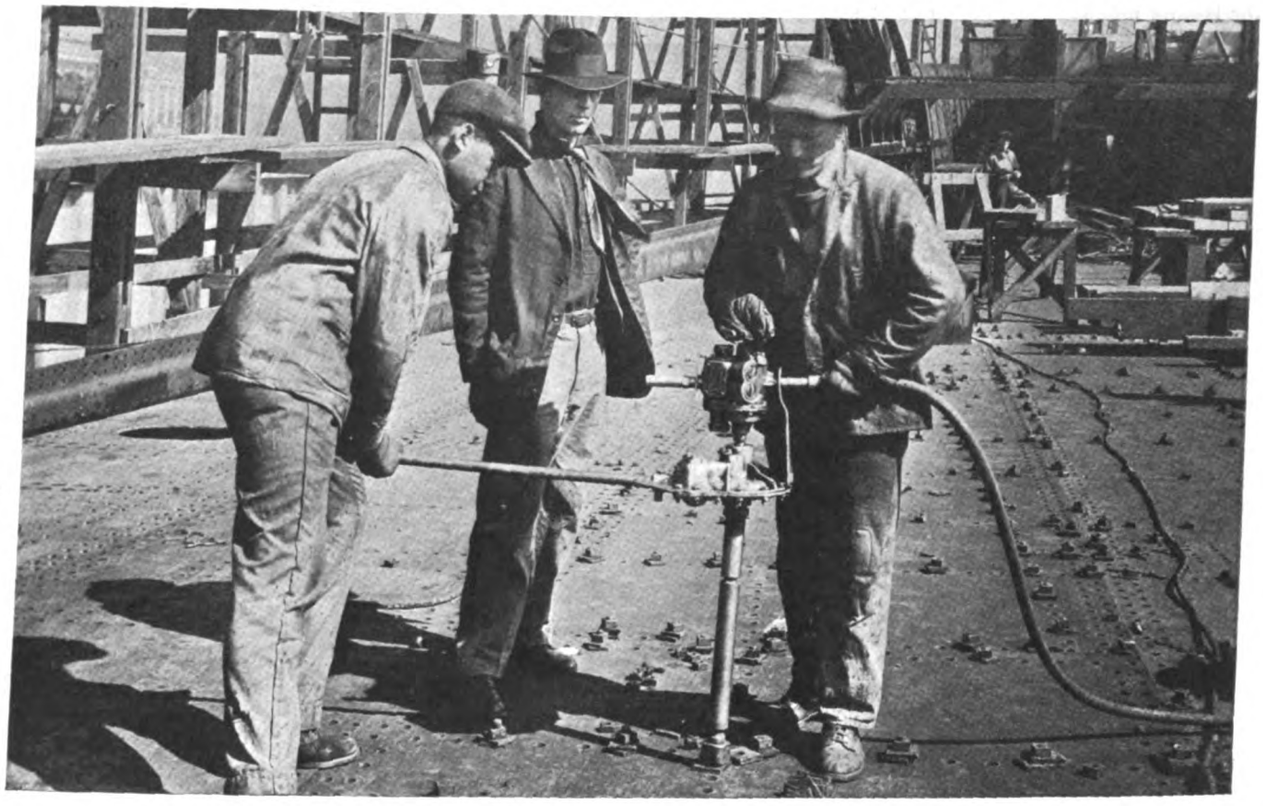

Fig. 1.—"Young" Nut Tightener in Operation

Shipbuilding Economies

Methods Employed at Puget Sound Navy Yard for Reducing the Cost of Ship Construction

BY COMMANDER G. A. BISSET, C. C., U. S. N.

IN its efforts to reduce the cost of shipbuilding during the past three years, the Puget Sound Navy Yard has been able to reduce very appreciably the cost at that yard. While these costs are doubtless considerably higher than at navy yards and shipyards that have had more shipbuilding experience, it is believed that the results of the Puget Sound experience may be of value to others engaged in shipbuilding. With this in view, some of the items that assisted in reducing costs are given below:

Bolting-Up Jacks

One of the shipfitters at the Puget Sound yard, Mr. W. F. Young, who had been in charge of the jacks used in pulling the faying surfaces of plates together, became disgusted with the inefficiency of the hydraulic type of jacks or "plate pullers" he was using and designed the jack shown in Fig. 2. The jack shown in Fig. 2 is a 60-ton jack, but these jacks are made in two sizes, 20-ton and 60-ton. The 20-ton jack weighs about 50 pounds and the 60-ton about 160 pounds.

It has been found that the new type of bolting-up jack, or, as it is more popularly called, "plate puller," operates very satisfactorily, in marked contrast to the hydraulic jacks, which, on account of the high pressure to which the valves were subjected, were constantly out of repair and leaking.

The 20-ton jack has been found suitable for practically all the new construction at this yard, and it has now become almost indispensable in bolting up heavy plating, particularly keel plates, tuck plates and plates near the bow and stern. New uses are constantly being found for the machine. It has been learned that there is a large field of usefulness for it in straightening out bent shapes and plates encountered in repair work, a number of jacks of this type having been used to advantage on a bottom job for the battleship *New York* in straightening out plates and frames. Fig. 3 shows the jack in use for removing dents in shell plates. The jack can be completely disassembled and reassembled in about five minutes, this feature being important, as little time is lost in case a bolt is

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broken and has to be replaced. Fig. 4 shows the jack disassembled.

The heavier type of jack, viz., the 60-ton, was developed to take care of any work liable to be encountered in the yard, it being assumed that it would be useful particularly for bolting up special treatment steel plates.

While Mr. Young has obtained a patent on the above device as well as upon the nut tightener described below,

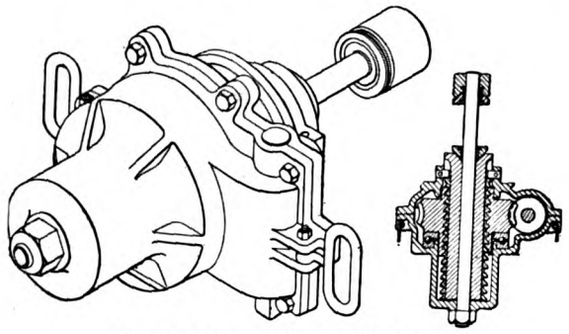

Fig. 2.—"Young" Bolting-Up Jack

the United States navy yards are permitted to manufacture and use them without paying royalty. The Puget Sound yard, with 2,300 employees in the hull division, has for several months had continual use for six of the 20-ton jacks, and the demand for the jack is such that it is proposed to manufacture more 20-ton jacks and probably three 60-ton jacks. These jacks cost about $95 each for the 20-ton and $325 each for the 60-ton.

Nut Tightener

The nut tightener shown in Fig. 5 and Fig. 6 is used for bolting up on new construction work. While it is not considered that this device is as indispensable as the jack, it is nevertheless very useful, and it is believed that by its use great saving can be effected in the bolting up of a ship. In the endeavor to keep down the weight of the machine to the minimum, the one shown in the figure is somewhat

Fig. 3.—Bolting-Up Jack Removing Dent from Ship Plate

too light, so that it is now out of repair more than it should be. The machine is being re-designed, however, to give additional strength. A suitable stock of these machines for the erection of a 10,000-ton vessel would be about six. Fig. 1 shows the machine in use.

Oxy-Acetylene Cutting

Fig. 7 shows the torch tip used for oxy-acetylene cutting at the Puget Sound Navy Yard, this tip being much more

Fig. 4.—Bolting-Up Jack Disassembled. Time Required to Disassemble About One Minute

economical than that furnished by the manufacturer with the cutting torches. The ratio of oxygen and acetylene used is believed to be about as follows: Standard tip to Puget Sound tip as two to one for both oxygen and acety-

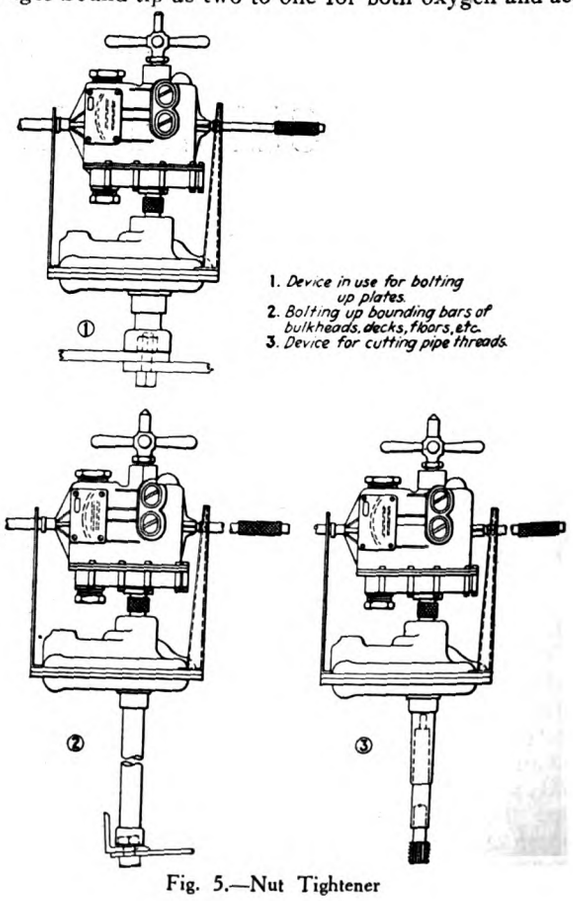
1. Device in use for bolting up plates.
2. Bolting up bounding bars of bulkheads, decks, floors, etc.
3. Device for cutting pipe threads.
①
②
③

Fig. 5.—Nut Tightener

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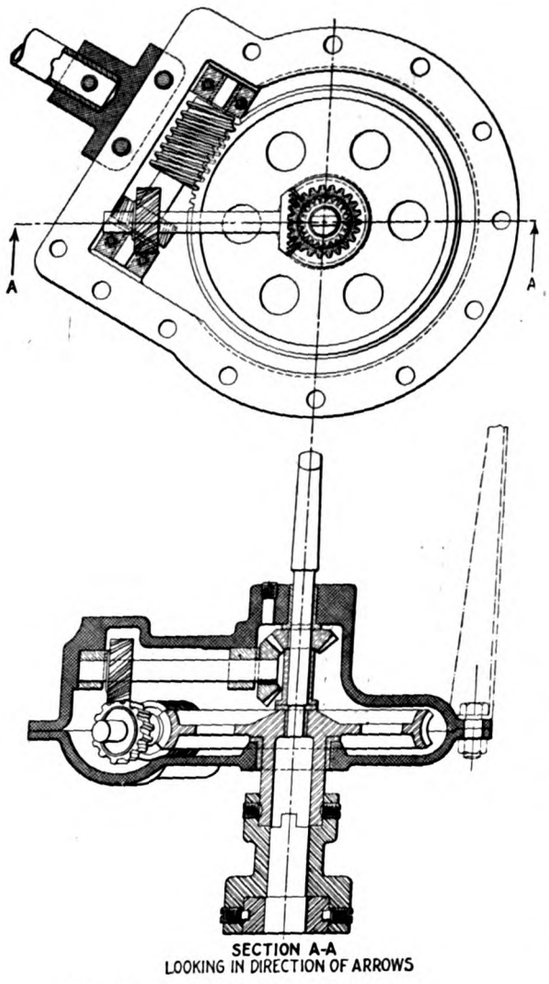

Fig. 6.—Details of Nut Tightener

lene. This torch can also be used for hydrogen, thereby making unnecessary the purchase of a *special hydrogen* torch at a cost of about $70.

The saving in oxygen and acetylene made by this torch appears to be due mainly to the more thorough mixing of the gases. A very appreciable saving in labor is likewise effected by this torch for the reason that it cuts more quickly than other designs, the improved torch cutting about 30 percent faster than the usual type.

OXY-ACETYLENE CUTTING UNDER WATER

While occasions for use of an oxy-acetylene cutting device during the construction periods of a vessel are very rare, the fact that the tip shown in Fig. 7 is adaptable for such work is considered to be of interest to many readers of this magazine. It will be readily apparent that such a device would be very valuable for salvaging material from sunken vessels.

The device, as equipped for submarine cutting, is shown in Fig. 8. An air jacket attached to the tip is supplied by a pipe with air compressed at a pressure of 100 pounds. Small lugs prevent the tip from touching the metal and extinguishing the flame, and the annular jet of air under the above pressure will effectually protect the flame at depths to about 200 feet without adjusting. An electrical device is used to light the torch under water, thus effecting a saving in gases, as the diver can extinguish and relight the torch as the work requires.

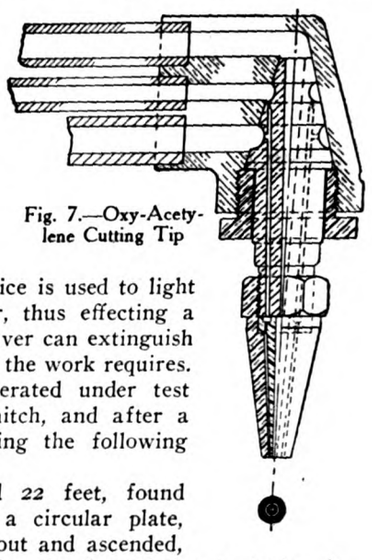

Fig. 7.—Oxy-Acetylene Cutting Tip

This device was operated under test without the slightest hitch, and after a few hours' experimenting the following record was made:

The diver descended 22 feet, found the steel and cut out a circular plate, retrieved the piece cut out and ascended, all in six minutes, the length of cut being 19 inches in 20-pound plate, oxygen at 65 pounds and acetylene at 24 pounds. Steel plating 1 inch thick was also cut at the rate of 6 inches per minute.

RIVETING

Perhaps the most important single labor item in the construction of a vessel is the riveting. A vessel of 10,000 tons displacement of the type of the ammunition ships built at the Puget Sound yard has about 1,200,000 rivets in its structure, exclusive of the rivets in manholes, doors, skylights, hatch covers and similar items. The labor cost of the 1,200,000 rivets in ammunition ship *No.* 1, which was built during war times when overtime was being worked and farmers were being taught to drive rivets, was about 13⅓ cents each. Ammunition ship *No.* 2, which was begun after conditions had become more favorable, was built at a labor cost per rivet about one-third less than *No.* 1, while the *Medusa*, now under construction, cost about two-thirds less—that is, about one-third as much as ammunition ship *No.* 1.

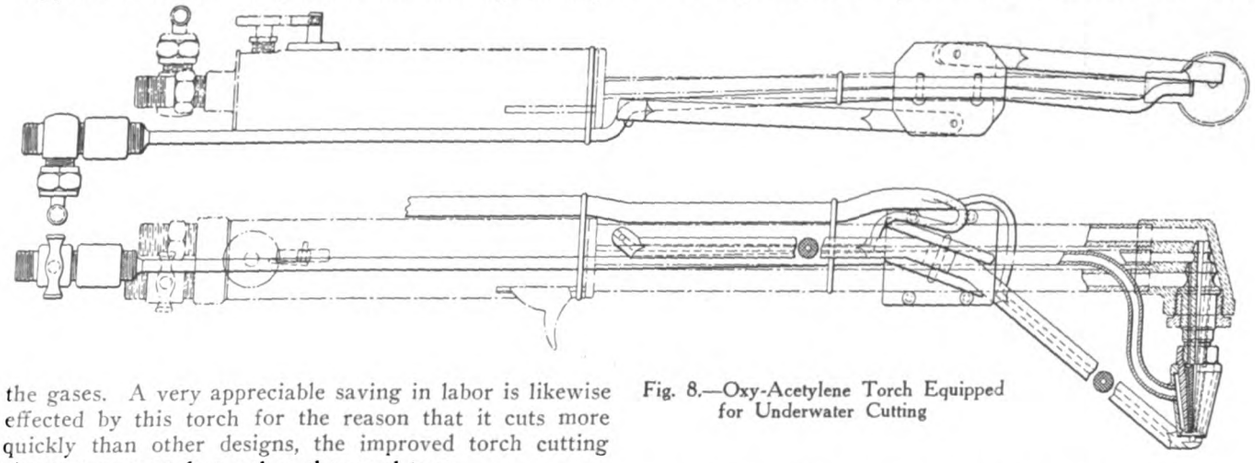

Fig. 8.—Oxy-Acetylene Torch Equipped for Underwater Cutting

While the costs were admittedly excessive originally and while the costs at present are not exceedingly low, it is

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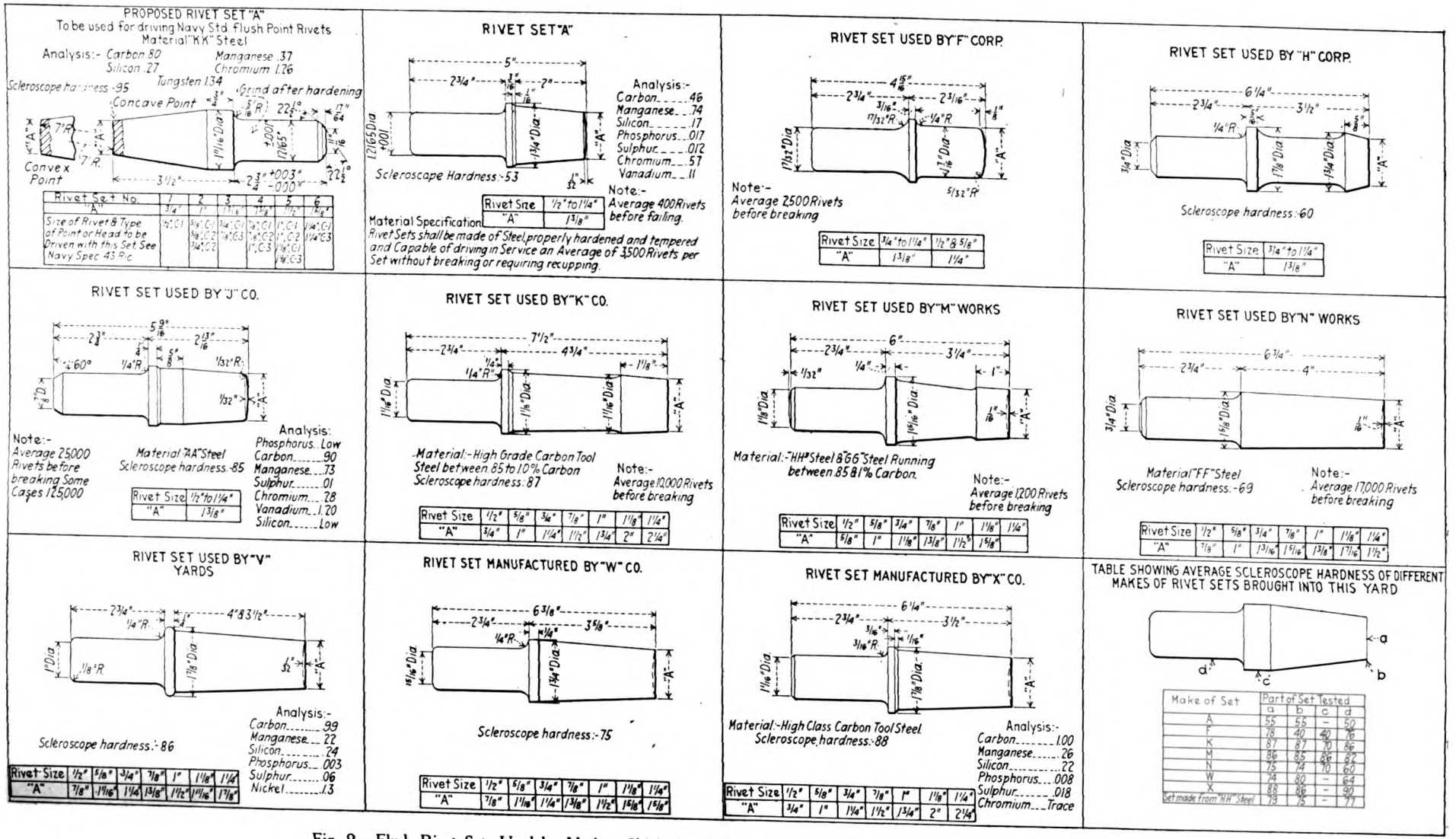
PROPOSED RIVET SET "A"
To be used for driving Navy Std. Flush Point Rivets
Material "K.K." Steel
Analysis:- Carbon .80 Manganese .37
Silicon .27 Chromium 1.26
Tungsten 1.34
Scleroscope hardness .95
(Grind after hardening)
Concave Point
Convex Point
RIVET SET "A"
Analysis:-
Carbon .46
Manganese .74
Silicon .17
Phosphorus .017
Sulphur .012
Chromium .57
Vanadium .11
Scleroscope Hardness:-53
Material Specification
Rivet Sets shall be made of Steel, properly hardened and tempered and Capable of driving in Service an Average of 3500 Rivets per Set without breaking or requiring recupping.
Note:- Average 400 Rivets before failing.
RIVET SET USED BY "F" CORP.
Note:- Average 2500 Rivets before breaking
RIVET SET USED BY "H" CORP.
Scleroscope hardness:-60
RIVET SET USED BY "J" CO.
Note:- Average 25000 Rivets before breaking Some Cases 125000
Material "A" Steel
Scleroscope hardness:-85
Analysis:
Phosphorus .Low
Carbon .90
Manganese .73
Sulphur .01
Chromium .28
Vanadium .20
Silicon .Low
RIVET SET USED BY "K" CO.
Material:- High Grade Carbon Tool Steel between .85 to 1.0% Carbon
Scleroscope hardness: 87
Note:- Average 12000 Rivets before breaking
RIVET SET USED BY "M" WORKS
Material:- "HH" Steel 8"66" Steel Running between .85 & 1% Carbon.
Note:- Average 1200 Rivets before breaking
RIVET SET USED BY "N" WORKS
Material "FF" Steel
Scleroscope hardness:-69
Note:- Average 17000 Rivets before breaking
RIVET SET USED BY "V" YARDS
Scleroscope hardness:-86
Analysis:-
Carbon .99
Manganese .22
Silicon .24
Phosphorus .003
Sulphur .06
Nickel .13
RIVET SET MANUFACTURED BY "W" CO.
Scleroscope hardness:-75
RIVET SET MANUFACTURED BY "X" CO.
Material:- High Class Carbon Tool Steel
Scleroscope hardness:-88
Analysis:-
Carbon .100
Manganese .26
Silicon .22
Phosphorus .008
Sulphur .018
Chromium Trace
TABLE SHOWING AVERAGE SCLEROSCOPE HARDNESS OF DIFFERENT MAKES OF RIVET SETS BROUGHT INTO THIS YARD

Rivet Set + No. "A"	1	2	3	4	5	6
Size of Rivet & Type of Point or Head to be Driven with this Set See Navy Spec 43 P.c	3/4"	1"	1 1/16"	1 1/8"	1 1/2"	1 5/8"
	1/2":C-1	5/8":C-1/ 3/4":C-2 / 7/8":C-2 / 1":C-3	3/4":C-1/ 7/8":C-2 / 1":C-3	3/4":C-1/ 7/8":C-2 / 1":C-3	1":C-1 / 1 1/16":C-2 / 1 1/8":C-3	1 1/4":C-1/ 1 1/4":C-3

Rivet Size "A"	1/2" to 1 1/4"	1 3/8"

Rivet Size "A"	3/4" to 1 1/4"	1 3/8"

Rivet Size "A"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"	1 1/4"
	3/4"	1"	1 1/4"	1 1/2"	1 3/4"	2"	2 1/4"

Rivet Size "A"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"	1 1/4"
	5/8"	1"	1 1/8"	1 3/8"	1 1/2"	1 5/8"	

Rivet Size "A"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"	1 1/4"
	7/8"	1"	1 1/16"	1 1/4"	1 3/8"	1 1/2"	1 5/8"	1 7/8"

Rivet Size "A"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"	1 1/8"
	7/8"	1 1/16"	1 1/4"	1 3/8"	1 1/2"	1 5/8"	1 5/8"

Rivet Size "A"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"	1 1/4"
	3/4"	1"	1 1/4"	1 1/2"	1 3/4"	2"	2 1/4"

Rivet Size	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"	1 1/4"
"A"	7/8"	1"	1 1/16"	1 1/8"	1 1/4"	1 3/8"	1 1/2"

Make of Set	Part of Set Tested			
	a	b	c	d
A	55	55	-	50
F	78	40	40	76
K	87	87	70	86
M	86	85	86	82
N	75	74	70	60
W	74	80	-	64
X	88	86	-	90
Set made from "HH" Steel	78	75	-	77

Fig. 9.—Flush Rivet Sets Used by Various Shipbuilding Firms in the United States for Driving Flush Point Rivets

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FIG. 10.—TABLE SHOWING FLUSH RIVET SETS DATA FURNISHED BY VARIOUS SHIPBUILDING FIRMS OF THE UNITED STATES

NAME OF SHIPBUILDING FIRM		"A"	"B"	"C"	"D"	"E"	"F"	"G"	"H"	"I"	"J"	"K"
Ships Delivered to U. S. Shipping Board First 11 Months 1918.	No. of Ships		15	7	4	7	7	2	6	7	4	87
	Total Tons Displacement		118300	31350	40805	51100	61250	19940	58300	46000	34500	305425
Diameter of Point of Rivet Set For Following Size Rivets	½" 5/8" ¾" 7/8" 1" 1⅛" 1¼"	1⅜"	1" 1⅜"	1¼" 1⅜"	¾" 1¼" 1⅜" 1½"	.... 1⅛" 1⅜" 1½"	1¼" 1⅜"	1" 1" 1⅛" 1⅛" 1½" 1⅝" 1¾"	.... 1⅜"	1⅜" 1⅜"	1⅜"	¾" 1" 1¼" 1½" 1¾" 2" 2¼"
Length of set outside of gun		2¼"	2¼"	4"	2"	3¼"	2¼"	3"	3½"	2¼"	2⅜"	4¾"
Shape of Point of rivet set		Convex	1/64" convex edge slightly rounded	Flat	Flat, sometimes concave	Concave	Convex	Concave	Flat or slightly Concave. Never convex	1/32" to 1/16" convex	Flat or slightly convex edge rounded 1/32"	½" to ¾" flat ⅞" to 1¼" concave.
Rivets driven per grinding		Not ground	Very seldom ground. Break before dulling	800	100 to 200	500	2 months	2 sets for 2 weeks	1500	Ground only once	1500 to 20,000 Sets rarely upset	Grind every 24 hours
Use of set for calking		Not with set	Not with set	Not with set	Not with set	Calk with set	Not with set	Not with set	Calk with set	Not with set	Not with set	Calk with set
Total rivets driven per set broken at shank		106	700 to 7000	1400	1200 to 1500	1000	100	5000 to 5500 with 2 sets	3000	10000	Approach 25000	10000
Average life of set		400	3 hours to 3 years	1400	1800	2000	2500	No definite record, many 2 years		Two months	Approach 25000 rivets. Some cases over 125,000	6 months
Kind of steel of which set is made and heat treatment given it		Sets are purchased	"BB" tool steel 3½ temper. Preheat slowly to 1300° F. Heat in lead bath 15 min. to 1440° F. Quench in brine 70° F. until cold. Draw in oil 1 hr 450° F. Cool slowly	"CC²" tough. Heated to 1400° F. Quench in fresh water. Draw in oil at 450° F.	"FF" standard No. 3 tempered steel. Heat to 1500° F. Cool in salt water. Draw to 450° F.	Sets are purchased	"CC¹"—XCL Harden at 1400° F. Draw in oil to 375° F. for 5 minutes	"CC²"-xx. heated to 1485° F. Quenched in water Drawn in Houghton's tempering oil 475°F. to 485° F. Cool in air.	Own design	"DD" extra steel "EE" steel Co.	"AA" tempered Vanadium tool steel, pat'd heat treatment	Sets are purchased
Cause of failure of set		Break at shank. Soft and cannot be hardened	Pointed pistons, peening action on end of shank. Fracture at shank	Using set until it becomes hot. Then cooling in water.	Fracture at shank	Fracture at shank	Shanks split due to pointed pistons	Allowing set to get too hot. Improper heat treatment	Due to splitting at the shank	Shanks split due to grinding end of piston	Fracture at the jointure of shank and body of set	Poor steel or poor tempering

NAME OF SHIPBUILDING FIRM		"L"	"M"	"N"	"O"	"P"	"Q"	"R"	"S"	"T"	"U"	"Y"
Ships delivered to U. S. Shipping Board first 11 months 1918.	No. of Ships	12	34	11	8	2	7	2	17	9	10	9
	Total tons Displacement	41200	116200	35080	70400	11000	25500	17600	188525	84600	88000	28500
Diameter of Point of Rivet Set For Following Size Rivets	½" 5/8" ¾" 7/8" 1" 1⅛" 1¼"	15/16" 1 1/16" 1 3/16" 1 5/16" 1 7/16" 1 9/16"	5/8" 1" 1¼" 1⅜" 1½" 1⅝"	7/8" 1" 1 3/16" 1 5/16" 1 7/16" 1½"	7/8" 1⅛" 1¼" 1⅜" 1½" 1⅝" 1¾"	1" 1⅛" 1¼" 1½" 1⅝" 1¾"	7/8" 1" 1 3/16" 1⅛" & 1⅜" 1 9/16" 1¾" 1⅞"	1" 1⅛" 1¼" 1⅜" 1½" 1⅝" 1¾"	7/8" 1¼" 1⅜" 1½" 1⅝" 1¾"	1" 1⅛" 1¼" 1⅜" 1½" 1⅝" 1¾"	1" 1⅛" 1¼" 1⅜" 1½" 1⅝" 1¾"	7/8" 1" 1¼" 1⅜" 1½" ....
Length of set outside of gun		4"	3¼"	4"	3½"	3¼"	3¾"	4¼"	4"	3½"	3½"	3¼"
Shape of point of rivet set		3/32" Concave	1/16" Concave	1/16" Concave	3/16" Concave	Concave	Concave	Concave	Concave	Concave	Concave	Concave
Rivets driven per grinding		200—1" Rivets 500—⅞" Rivets	500	400	25 to 50	500	100 to 400	with set	500	45	100	25
Use of set for calking		Draws in edge	Calk with set	Draws in edge	Not with set	Calk with set	Calk with set	Calk with set	Calk with set	Calk with set	Calk with set	Not with set
Total rivets driven per set broken at shank		No record	No record	Very few break at shank	75 to 100	500	500 to 3000	3000	4000	No record	200	
Average life of set		10000	12000	17000 to 20000	400 to 600	No record	5000 to 7000		4000	5000	6 months to 1 year	No record
Kind of steel of which set is made and heat treatment given it		"FF" tool steel. Heat to dark cherry red. Quench in water. Draw to light blue	"GG" or "HH" Heated at 1200° F. to 1300° F. Drawn at 450° F.	"FF" No. 3 temper. st'd. tool steel heated 100° F. put in. lime. Heated 1450° F. Quenched in water Drawn 400° F. Dipped in black tempering oil. Cannot complain of a common cause.	Sets are purchased	Sets are purchased	"HH" special grade No. 7 tool steel annealed heat 1420° F. Quench in salt water 520° F. Cool in air.	0.80% carbon tool steel and vanadium tool steel	"CC4" xxx tool steel 1% carbon. Heat 1300° F, Quench in water. Temper in oil. Draw to 300° F.	"GG" steel. Tempered by Wheeler process	Heat in gas furnace to 1200° F. Quench in warm water	Sets are purchased
Cause of failure of set		Tool marks or water cracks leading to fracture	Poor steel. Machining and hardening tool marks,	Too soft	Poor steel	Break at shank. Not finished properly. Tool marks.	Crystalization	Poor steel, tool marks	Temper too hard. Gun socket worn	Improper heat treatment		

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believed that other yards, by applying the lessons learned, may be able to reduce their costs regardless of what they are at present.

In this connection it seems pertinent to discuss piece work riveting as compared with day work riveting. At yards where the conditions are similar to those existing at present in the Puget Sound yard, viz., with not enough riveting work ahead to employ many riveters, it is undesirable to use piece work riveting. There are now only about fourteen gangs used on new construction, and if piece work were used a smaller number of gangs would doubtless drive the same number of rivets as at present.

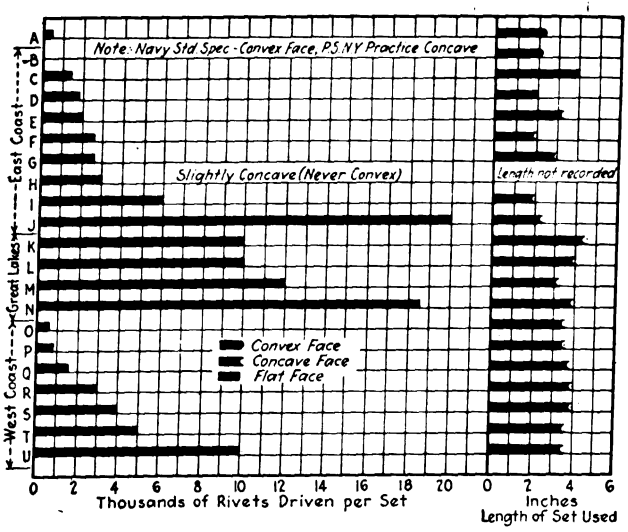

Fig. 11.—Comparative Chart Showing Average Rivets Driven Per Set in 21 Leading American Shipyards; Also Showing Lengths of the Three Sets in Use

With delay in the delivery of structural steel, the work cannot be prepared for the riveter fast enough to make it possible to drive more than about the number of rivets now driven by the fourteen gangs. The use of piece work would, therefore, mean the discharge of some of our riveters and consequently the unavailability of these riveters for *urgent repair work*, availability of men for repair work being the excuse for the existence of navy yards. The introduction of piece work at this yard would also undoubtedly mean an increase in the labor cost of the rivets, as only those that would drive more than an ordinary day's work would do piece work, while the others would drive rivets on day work.

At private shipyards, where all the considerations that enter into overhead expense must be borne in mind, it is believed that any other system than piece work is out of the question. To show why any other system is out of the question it is necessary to make some assumptions. Assume, therefore, that a $2,000,000 vessel is being constructed; that a limited number of good riveters are available for work on the vessel, say fifteen; that these men doing piece work can drive 50 percent more than by day work, and that their output is correspondingly increased from, say, 300 rivets per gang per day to 450. Assume, also, that there are 1,200,000 rivets in the vessel.

On the above assumptions it will take 267 days to drive the rivets by day work and 178 days by piece work. It is clear, therefore, that by doing piece work the construction of the vessel would be shortened 89 days, which means that an amount of money representing the value of the vessel, viz., $2,000,000, would be tied up for 89 days less if piece work were used. The interest on $2,000,000 at 6 percent for this number of days amounts to $30,000. While this is not the only saving due to piece work, it probably represents the most important item.

In beginning the study of riveting it is evident that the subject naturally divides itself into two parts, viz., material and personnel—in other words, "the tools" and "the men." As the personnel question tends to settle itself, particularly when piece work is used, the discussion below will consider tools exclusively, except in a number of cases where the morale of the personnel is affected by the tools. Under material will be included also methods and processes.

Rivet Sets

The most important item under material is, of course, the riveting gun, and the part of the gun capable of the most development is the rivet set. While not, strictly speaking, a part of the riveting gun, the set is a part of the rivet driving apparatus.

While investigating rivet sets, twenty-one shipbuilding firms in the United States were interrogated, these firms representing geographically practically all shipbuilding sections of the country. In tabulating replies from the different shipyards, the results being shown in Figs. 9, 10 and 11, the first surprising fact that became evident was that the use of rivet sets with convex points was restricted to the east coast, while all the west coast and Great Lakes yards, and even some of the east coast yards, use rivet sets with concave points. When the concave point is used the concavity amounts to about 1/32 inch. Instead of rounding the edge of the set it is left sharp, so that it can be used to cut off the surplus metal remaining after the rivet holes and countersink are completely filled. This edge is also used to finish off and calk the rivet in a single operation.

It was found also, moreover, that of the twenty-one shipbuilding plants interrogated, not more than three of these plants use a single standard diameter of point of set, 1⅜ inches being the diameter used when only one size is employed. When the convex point is used the diameter of the set may be maintained 1⅜ inches. Where concave points are used, however, it is necessary to have the diameter of the point of the set equal to or slightly smaller than the diameter of the countersink. This necessitates the use of sets with points of several different dimensions, the variation between the diameter of the rivet and the diameter of the point of the set being from ¼ inch to 9/16 inch. The variation in the size of sets used by various shipbuilding firms is illustrated by Figs. 9 and 10.

An absolutely flush rivet cannot be driven with a concave set, and for that reason it is not as suitable as the convex set for driving rivets in decks, if the deck is to be planked or covered in any way. Although a sound, watertight rivet can be driven with either type of rivet set, it has been found in practice that the concave sets drive rivets equally as good in quality and of a much neater appearance than can be driven with the convex type. The concave set drives the rivet, removes all excess metal and calks the rivet in one operation. However, the point of the rivet is liable to be a little high in the center, due to the concavity of the set, and if an absolutely flush rivet is required, the point may have to be chipped off a little. This objectionable feature is being reduced by a tendency to flatten out the concavity of the set. Doubtless, eventually, the west coast yards will use a rivet set with a flat point, the essential feature being that the edge will be kept sharp, with no rounding, in order that the excess metal of the rivet may be cut off without using an extra tool. This will also obviate an objection that has been raised, though not observed at this yard, that the concave pointed sets mar the plating around the point of the rivet.

If all the rivet holes were fair and countersinks uniform

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in depth, rivets of suitable length could be selected so that the hole and countersink would be completely filled, and at the same time no surplus metal would be left to be disposed of. The convex set would then be satisfactory for all classes of flush riveting and the work of such a nature that the calking of most of the rivets could be dispensed with. It would also require less skill to perform satisfactory riveting, although it is somewhat harder on the riveter to hold the convex pointed set on the rivet. However, the holes and the countersinks are never of uniform size, which is mainly the result of reaming, necessitated by the structure not lining up properly. It is difficult, if not impossible, to select a rivet of the exact length required for each individual hole. As a result, the rivets selected are a little long to insure sufficient rivet stock to fill unfair holes that have been reamed and recountersunk. This leaves a certain amount of excess metal which must be removed either with a chisel or with the sharp edge of the rivet set.

In driving with a convex set, the riveter is either equipped with a chipping gun or with a chisel to fit his riveting gun. After the rivet has been upset and worked into the hole and the excess metal, if any, worked to one side, the riveter either places a chisel in his riveting gun or uses a chipping gun, as the case may be, to remove this excess metal. He then takes up his riveting gun again and goes over the rivet to finish it. On deck riveting the change from riveting gun to chipping gun and vice versa can be made easily and quickly, as the tools can be placed near the work. On shell riveting, however, the tools must be placed on some sort of stand or hung on a hook. In changing from one tool to another, therefore, considerable time is lost, and in addition to this a riveter working on the shell frequently drops his tools or they may roll off the stage plank on account of the vibration due to the riveting. This delays the riveting until the tools are recovered, which requires considerable time and involves an accident hazard for those working below.

It was ascertained at this yard that the type of rivet set designed exclusively for use as a convex set would not give satisfactory service, if ground concave. In using, for instance, the set *"A"* shown near the left hand upper corner of Fig. 9 as a concave set the following objections were observed:

(1) The body of the set is too short to provide a good grip for the operator to hold the set, it being only 2¼ inches long.

(2) Due to the shortness of the set, the riveter's hand is brought so near the hot rivet that his glove is soon burned through and his hand consequently liable to injury. This not only causes suffering and inconvenience on his part, but decreases his efficiency to a considerable extent on account of the precautions he will naturally take.

(3) The riveter's "boot" and glove cover the work to such an extent that it is extremely difficult to see what he is doing.

(4) It is impossible to drive properly a rivet with a short set when the rivet is near the bosom of an angle or close to service bolts and similar obstructions, for the reason that the barrel of the riveting gun, which is approximately 2½ inches in diameter, comes in contact with these obstructions, prohibiting the rolling motion of the gun which is necessary to finish the rivet.

(5) Fig. 10 shows that the average number of rivets driven per grinding with the flat point, or concave point, sets runs up as high as 1,500, while at this yard the corresponding figure was about 60.

(6) The scleroscope hardness of the set, viz., 53, is much too low for a satisfactory concave pointed set. The hardness should range between 75 and 95.

(7) The chemical analysis of the material from which this set is made is as follows:

Carbon	.46	Sulphur	.012
Manganese	.74	Vanadium	.11
Silicon	.17	Chromium	.57
Phosphorus	.017		

Steel of this chemical content shows little response to heat treatment, and it appears impracticable to give it a treatment that will make it satisfactory for use in concave sets.

(8) The collar shown just below the fillet of the shank of the set is undesirable. As the sets are turned from bar stock it is apparent that where the collar is required the waste material is considerably greater than where the collar is omitted. Moreover, where the collar is present satisfactory heat treating is more difficult, particularly where there is a sharp angle below the collar. It has been

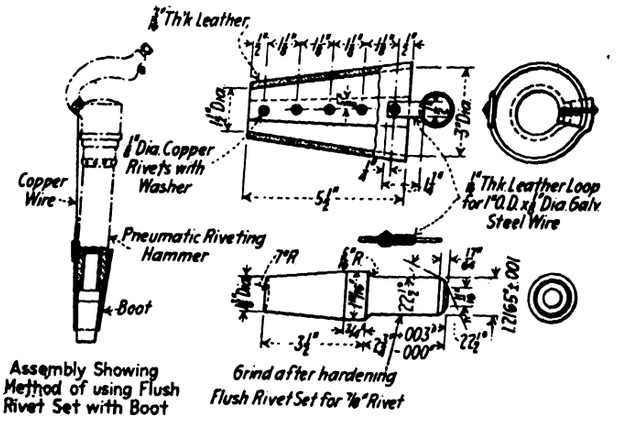
⅛" Thk Leather
⅛" Dia.
⅝" Dia.
⅜" Dia. Copper Rivets with Washer
Copper Wire
5¼"
1" Thk Leather Loop for 1" O.D. x ⅝" Dia. Galv. Steel Wire
Pneumatic Riveting Hammer
Boot
Assembly Showing Method of using Flush Rivet Set with Boot
Grind after hardening Flush Rivet Set for ⅞" Rivet

Fig. 12.—Flush Rivet Set and Boot

found that frequently, while the set is in use, the collar will chip off, damaging the set and the riveting gun. The collar was used in connection with a clip that held the rivet set in the gun. This clip was larger in diameter than the barrel of the gun, being too large to permit the operator to close his hand tightly around the set. The clip, moreover, bore on a small area in the palm of the hand in such a way as to make the palm sore in a short time. After some experimenting the type of "boot" shown in Fig. 12, which is made of chrome leather and held in place with copper wire, was found to give much better results. With this "boot" the riveter can encircle the set completely with his hand and consequently has the set in much better control than formerly.

(9) The upper end of the shank has the corners rounded off to a radius of ⅛ inch only. A radius of 5/16 inch should be used instead, or preferably two conical surfaces as shown in Fig. 12, the conical surfaces constituting a smaller machining operation than the rounded surfaces. The net result is the same, viz., that the diameter of the point of the shank upon which the piston impinges is 11/16 inch, the same as the diameter of the point of the piston. This not only prevents the piston and the set from indenting each other, but also prevents upsetting the end of the shank and causing the edges to chip off or expand and jam in the barrel of the gun. This rounding also facilitates the exhausting of air ahead of the piston on the down stroke and likewise facilitates the entry of the air to force the piston back on the return stroke. In this way the piston is given a greater speed, which shortens the operation of driving the rivet.

(10) The fillet at the juncture of the shank and body is 3/16 inch in this set. This radius should be 5/16 inch to make it correspond with the radius of the inner lip of the riveting gun barrel. When these dimensions are the

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Fig. 13.—Riveting Between Service Bolts With Present Navy Standard Type E Rivet Set, Showing Difficulty of Using Short Set and Liability of Injuring Operator's Hand

Fig. 14.—Riveting Between Service Bolts With Proposed Standard Set, Showing Ease With Which Set is Used. Rivet Being Driven Straight Down to Swell the Shank of Rivet and Fill Hole

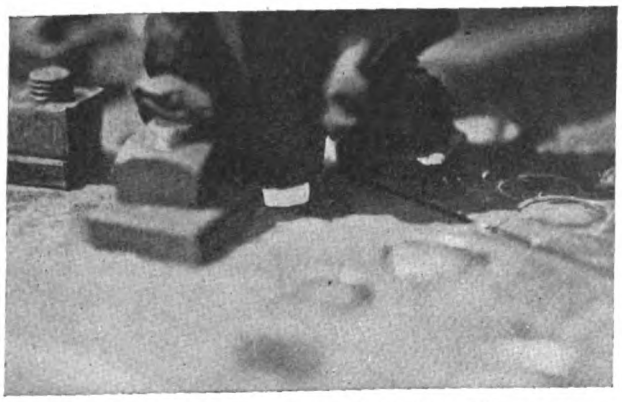

Fig. 15.—First Operation in Driving a Flush Rivet, Showing Rivet Being Driven Straight Down to Swell the Shank of the Rivet and Fill the Hole

Fig. 16.—Driving Straight Down With Proposed Standard Set to Swell Rivet Shank and Fill Hole

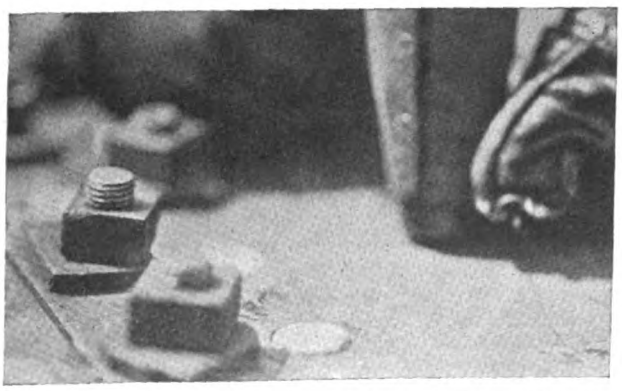

Fig. 17.—Rivet in Center Foreground Partially Driven, Showing That Rivet is Driven Straight Down With Concave Set to Swell Shank and Completely Fill Hole. Metal Expanded Equally in All Directions. Rivet is Still to Be Driven Securely Into Countersink, Calked and Excess Material Removed

Fig. 18.—Calking and Removing Excess Material from Rivet With Proposed Standard Set

same, the set fits snugly in the end of the gun and consequently is much more easily handled by the riveter. Moreover, with the larger radius of the fillet the liability of developing internal stresses during the heat treating process is minimized.

(11) Where the set is so short the heat from the rivet causes the shank to expand with danger of jamming in the barrel of the gun. Unless longer sets are used it is necessary to change the sets often to permit them to cool off.

(16) While heretofore a rivet set driving 3,500 rivets before failure was considered satisfactory, it has been found practicable to obtain sets that will drive easily from 12,000 to 18,000 rivets before failure. They can also be so heat treated as to drive at least 400 rivets without regrinding. It is desirable that a rivet set be able to drive all the rivets a man can drive in eight hours without regrinding, so that no delay will be caused during the day by sending the set back to the grinder.

(17) Steel showing chemical content as follows has been found to give excellent results when made up into rivet sets, the set used being the design shown in Fig. 9 as the proposed standard "*A*."

Carbon	.80	Manganese	.37
Silicon	.27	Chromium	1.26
Tungsten	1.34		

The heat treatment of this steel consists merely of quenching in oil from 1,750 degrees F., the temper not being drawn at all.

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Fig. 19.—Removing Excess Material During Calking Operation

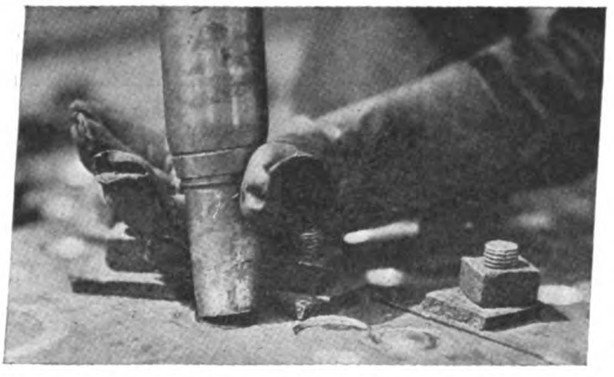

Fig. 20.—Calking Finished Rivet While Still Hot

(18) While tests were conducted at this yard to ascertain which type of set as between the convex and the concave could drive rivets at the lower cost, it is considered that the tests were hardly fair to the convex sets in view of the greater familiarity of the west coast riveters with the concave set. It was found that where the points of the rivets have to be calked the concave set is much preferable, the calking being done while the rivet is still being held on. Unless the rivet is held on while the point is being calked, it is liable to be loosened. It would manifestly be much more expensive to calk the rivet if the calking were performed in an entirely separate operation with a holder-on helping the calker. In the riveting of decks that are to be covered with linoleum or wood decking, however, it is desirable that the convex point sets be used.

It is considered that the proposed set shown in Fig. 9 eliminates all the objections encountered, the set being of the chemical content recommended elsewhere above. While this set is considerably heavier than the lighter set heretofore used, its increased life much more than makes up for the greater first cost. Its greater output at one grinding likewise removes a source of great annoyance. The inertia of the heavier set will, it is believed, result in less vibration of the gun, while its great reliability will prevent the frequent recourse to the tool room, will not afford the riveters excuses for small output, and will better the morale of the working force besides being more popular with the piece workers.

The advantages of the proposed standard rivet set are further illustrated by Figs. 13 to 21 inclusive, which are actual photographs taken from work.

PISTONS

It is found that the standard pistons furnished with the 6-inch riveting guns are 3 inches in length. As it was learned that the men were continually removing the standard pistons and using 2½-inch pistons in these guns, the question of the most efficient length of piston was investigated.

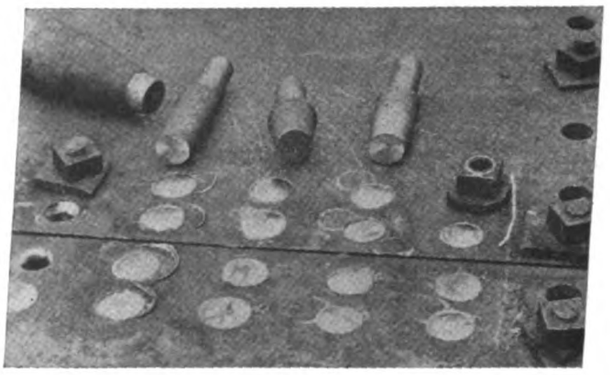

Fig. 21.—View Showing Rivets Driven With Navy Standard and Proposed Rivet Set, Showing Rivets Tightly Calked With Proposed Set But Loosely Calked With Standard Set

While the manufacturers of the riveting gun recommend the 3-inch piston, it was found that with the 2½-inch piston a rivet could be driven in appreciably less time. It is believed that this result is due to the fact that the shorter piston travels further and consequently attains a higher speed at the time it strikes the end of the rivet set. Its momentum is, therefore, greater in proportion to its weight than is the momentum of the heavier piston. On account of its lesser weight, moreover, its inertia is less, so that the return stroke is quicker than in the case of the heavier piston. Increasing the number of strokes naturally reduces the vibration of the gun, very much in the way that the vibration of a steam engine is reduced when three cylinders are used instead of two.

This yard has no facilities for counting the strokes of the hammer with different size pistons, but it is believed that this whole question is one of sufficient importance to warrant the conducting of a series of tests that would give the most efficient length of piston for each size of riveting gun.

RIVET FORGES

Electric forges for heating rivets by placing them between electrodes have been tried at a number of places on ship work and appear to be unsatisfactory. While electric furnaces have not been tried at this yard, it is believed that the heating cost would be excessive.

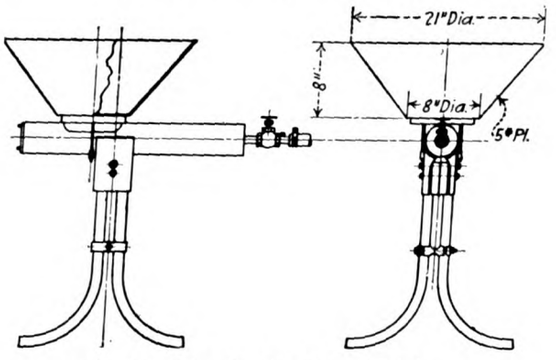

Fig. 22.—Rivet Heating Forge (Coke)

Oil forges have possibilities. Unless the oil forges, however, are fitted with a tank sufficient to hold more than a day's requirements of oil, they are unpopular and inefficient. Moreover, more skill is required of the heaters in using oil forges, as otherwise the rivets are liable to be

(*Concluded on page 907.*)

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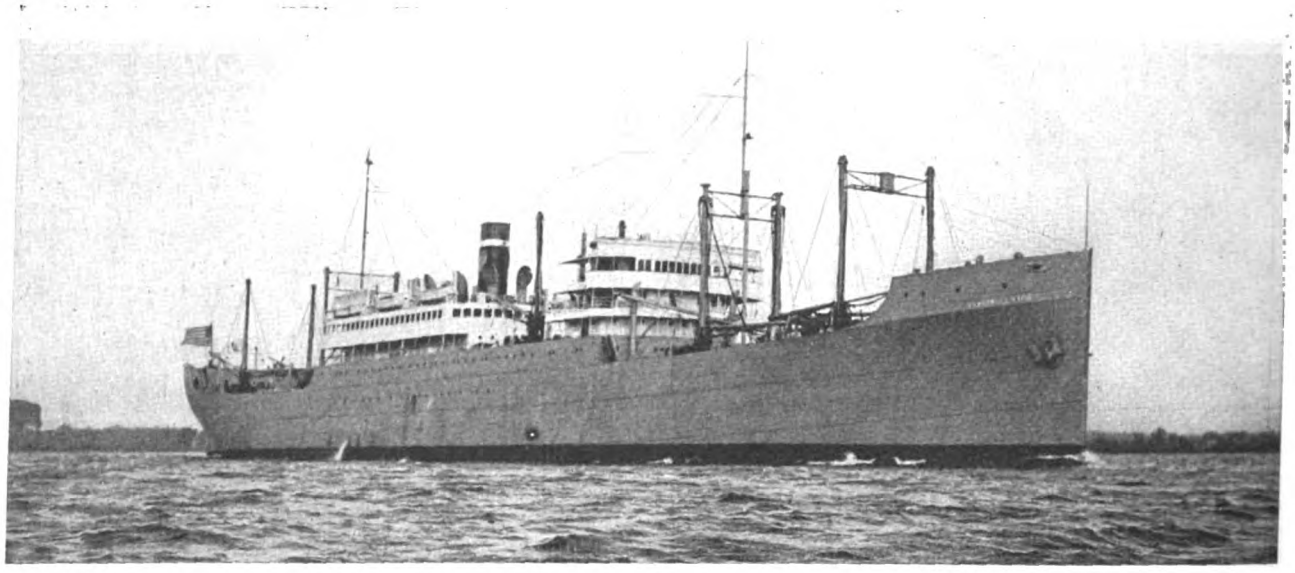

Fig. 1.—S. S. *Panhandle State* Leaving the Builders' Yard

Passenger Accommodations on Shipping Board Steamship Panhandle State

Arrangement of Living Quarters on First Passenger Vessel Completed by an American Yard for the United States Shipping Board

THE steamship *Panhandle State* recently placed in commission in the transatlantic service is the first ship to be completed of a group of seven combined passenger and freight vessels being built by the New York Shipbuilding Corporation at Camden, N. J. The structural features of these ships were fully described in the April, 1920, issue of MARINE ENGINEERING. Some of the principal dimensions are here repeated, as follows:

Length overall	522 feet 5 inches
Length between perpendiculars	502 feet
Beam, molded	62 feet
Depth to "A" deck	42 feet
Draft, summer	32 feet 3 inches
Gross tonnage	10,533
Deadweight tonnage	13,100
Service speed	14 knots
Indicated horsepower	7,000

These vessels have limited passenger accommodations, being fitted up for 78 first class passengers. No second or third class passengers are carried. The staterooms and public rooms are situated on the "A" deck within the bridge, also on the bridge and promenade decks above. They are spacious and luxuriously appointed. The designs for the interior decoration are by W. and J. Sloane, of New York, which firm also supplied some of the furniture.

Staterooms on the Promenade Deck

In the forward end of the promenade deck house there are nine staterooms, each for two persons. These rooms measure 9 feet 3 inches by 8 feet, with 7 feet 3 inches clear headroom, and are finished in white with mahogany trim. They are furnished with two single beds of square metal tubing enameled to harmonize with the finish of the rooms, a mahogany dressing table of pleasing design, a comfortable, upholstered chair, a lavatory and a wardrobe. The floor is carpeted. Four of these rooms communicate with shower bath rooms.

Between the boiler and engine casings there is a spacious lobby at the head of the staircase leading down to the bridge deck. The after end of the house is given over to the smoking room, which is finished in fumed oak, mission style, with a tiled floor and deep beamed ceiling. An electric fireplace occupies the center of the forward side, flanked by upholstered seats. The sides of the room are divided into cozy alcoves.

No air ports are fitted in the promenade deck house, their places being taken by large rectangular windows of novel design, arranged with a narrow stationary upper sash and a large movable lower sash, permitting clear vision at all times by avoiding the obstruction of the old-style meeting rail. A shallow inner frame allows ventilation without drafts when the sash is raised a few inches.

Enclosed Promenade Deck

An enclosed promenade extends the full length of the deck on both sides, 95 feet long and 8 feet wide, the outboard side above the bulwark being fitted with vertical sliding windows of the Laycock type, which may be opened in fair weather. Abaft the house there is an additional open promenade 24 feet square.

Extending across the front of the bridge deck house, with deep wings running aft alongside the boiler casing, is the social hall, finished in white in the Adams design with upholstered mahogany furniture. The floor is carpeted in gray. A stair with gracefully curving balustrades descends to the "A" deck. A feature of the passenger stairways is the elimination of the usual brass nosing and kick plates. The stair risers as well as the treads are rabbeted to receive rubber tiling which presents a flush surface and gives the effect of a carpet runner.

Bridge Deck Staterooms

Ten staterooms, similar to those on the promenade deck, occupy the sides of the bridge deck house abaft the social hall. These rooms are arranged in pairs with shower

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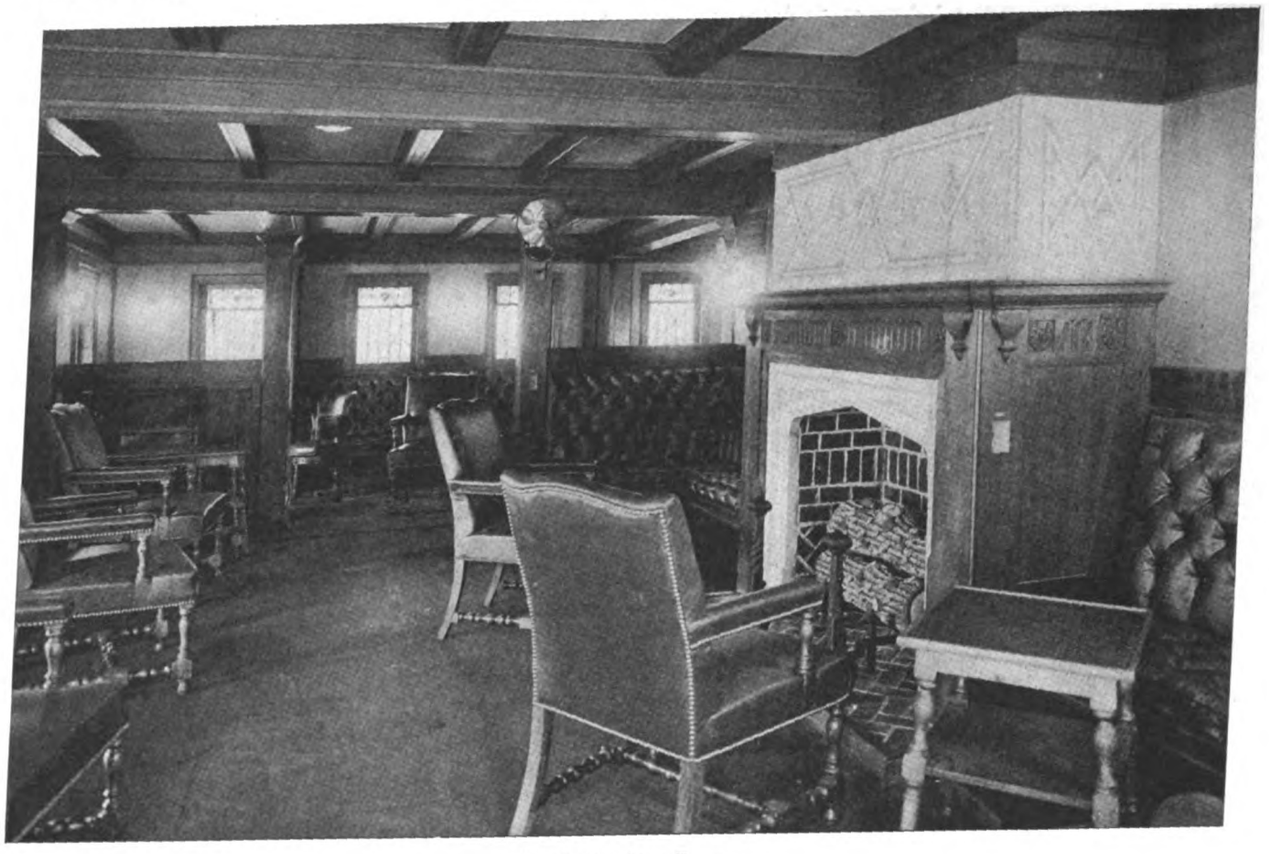

Fig. 2.—Smoking Room

Fig. 3.—Dining Room

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Fig. 4.—Lobby

Fig. 5.—Social Hall

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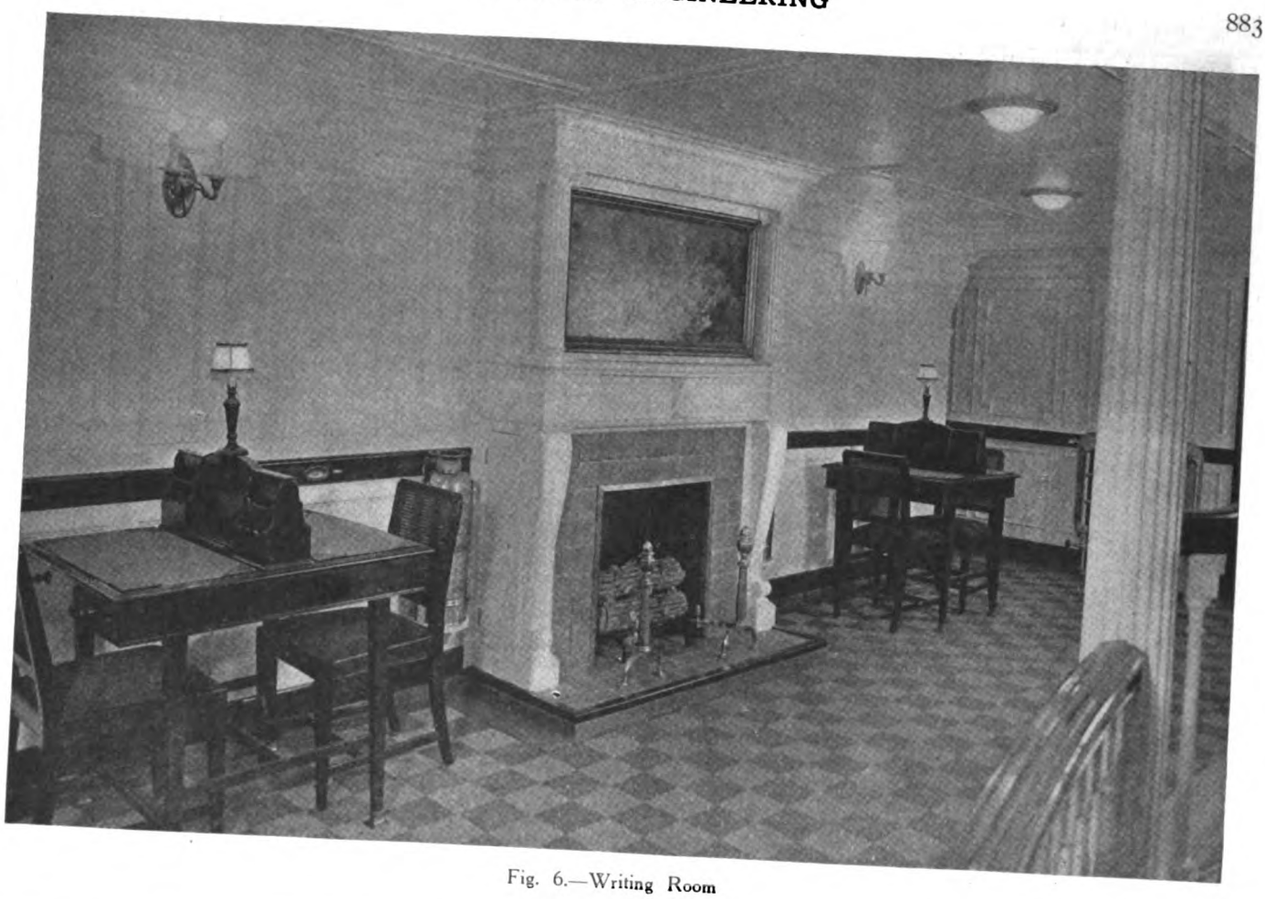

Fig. 6.—Writing Room

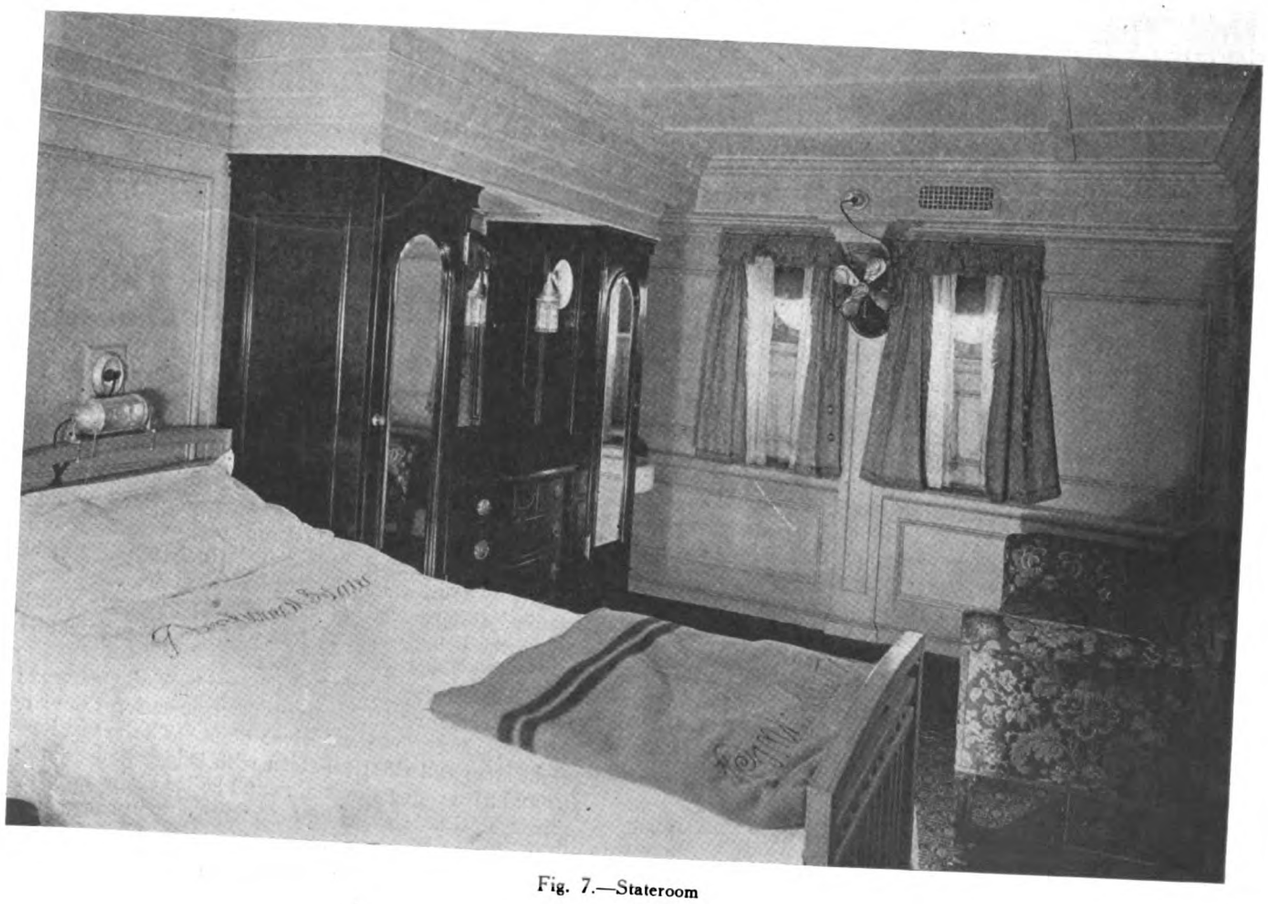

Fig. 7.—Stateroom

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bath rooms between. A writing room with the conventional tables is located between the boiler and engine casings. Here there is an electric fireplace surmounted by a floral panel piece done in oil. A veranda café, open to the air on one side, faces the promenade at the after end of the deck. The finish is weathered oak in a carved trellis design that carries out the idea of a shaded garden. Between the deck house and the ship's side there is an open promenade 9 feet wide.

It is on the "A" deck, however, that most of the passengers are accommodated, there being twenty staterooms for two passengers each. The greater width available on this deck also permits larger rooms than those in the superstructure. These are 9 feet 6 inches long and 16 feet wide. The finish is white and trimmed with mahogany, uniform in style with the other rooms, but the furniture is a trifle more elaborate, although very simple and neat in design. Sixteen of these rooms have two beds each, one stationary and one folding, a sofa, two built-in wardrobes and two chiffoniers. A bath room is located between each pair of staterooms. Four rooms amidships are fitted up as bridal suites, with baths, and have two stationary beds, a large upholstered sofa and a combined dresser, chiffonier and wardrobe. The doors of these wardrobes have full-length mirrors which can be swung to any desired angle.

Dining Saloon Arrangements

The dining saloon, with seating capacity for all the passengers at one time, is located at the forward end of the bridge on the "A" deck. It is lighted by air ports on three sides, the ports being masked behind glazed sashes of pleasing design. The scheme of finish and furniture here is colonial, in white and mahogany. The pantry is located in close proximity to the dining saloon, over the galley, which is on "B" deck.

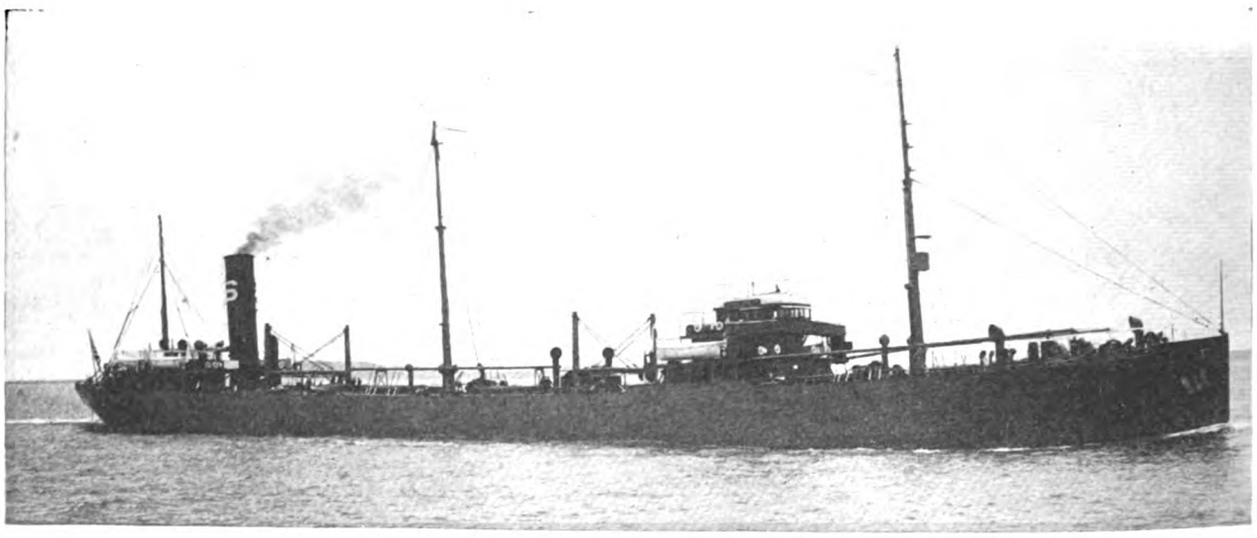
The dining saloon and staterooms on the "A" deck are supplied with heated fresh air by a thermotank system of forced ventilation. Throughout the passenger spaces there are radiators and a profusion of electric fans to insure the comfort of the passengers regardless of the condition of the weather.

The electric lighting fixtures have received special attention and harmonize perfectly with the decorative treatment of the rooms. In short, everything has been done to place these ships on an equal footing with the finest ships in service.

Panhandle State in Service of American Company

The keel of the *Panhandle State* was laid in 1919. The vessel was launched March 9 of this year and the acceptance trials were run August 19. Construction of the vessel was commenced during the war, when it was planned to utilize her as a troopship. While still under construction, however, she was re-designed as a combination passenger and cargo vessel, and for this reason her completion was greatly delayed.

Since leaving the yard at Camden the steamer proceeded to New York, where she took on a full cargo and passengers for her maiden voyage in the New York-Queenstown-Boulogne-London service, to which route she has been assigned under the flag of the United States Mail Steamship Company, New York. The vessel is commanded by Captain C. M. Stone, while the chief engineer is Albert W. Young.



Trial Trip of the *China Arrow*, October 1, 1920

Tank Steamer China Arrow Delivered to Standard Transportation Company

THE Fore River plant of the Bethlehem Shipbuilding Corporation, Quincy, Mass., has just completed for the Standard Transportation Company, New York, the single screw tank steamer *China Arrow*, a shelter deck Isherwood framed vessel 485 feet long, 62 feet 6 inches beam, 39 feet 6 inches depth and about 26 feet 6 inches draft. Propulsion is by a triple expansion, four cylinder, direct acting, surface condensing reciprocating engine with cylinders 24 inches, 35 inches, 51 inches and 75 inches diameter, all with a common stroke of 51 inches. Steam is supplied at a pressure of 220 pounds per square inch by three Scotch boilers each 15 feet 3 inches diameter and 11 feet 6 inches long.

The *China Arrow* is the first of four bulk oil steamers to be constructed for the Standard Transportation Company, of New York, at the Fore River plant. The vessel has a straight stem and elliptical stern with bridge houses amidships and aft around the engine and boiler casings. There are three steel pole masts and ten double main cargo tanks with a combined capacity of 3,665,700 United States gallons.

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6,300-Ton Deadweight Freighter

Economical Type of Cargo Steamer Designed by the Baltimore Dry Docks and Ship Building Company

DUE to the slowly dropping freight rates and the keen competition developing in marine transportation, it becomes more and more important to the ship operator to consider the possibilities of economies in operation costs resulting from the properly co-ordinated design of carriers.

With this in mind, the Baltimore Dry Docks and Ship Building Company, Baltimore, Md., has designed and now has under construction a somewhat new type of general cargo steamer combining in one design many of the factors found through long experience by this company to be conducive to the most economical handling and delivery of general cargo. This design will be constructed as a stock ship and is expected to find a ready market on account of its many attractive features.

PRINCIPAL ATTRACTIVE FEATURES

1. Economical propulsion.
2. Large cubic capacity.
3. Maximum tonnage exemption.
4. Large cruising radius.
5. Quick change oil to coal or vice versa.
6. Elaborate cargo handling facilities.
7. Large clear holds of about equal capacity.
8. Arranged for efficient stowage of grain or baled cotton.
9. Mast heights to enter Manchester Canal.
10. Well arranged quarters.
11. Modern design of propelling machinery.
12. Isherwood construction and dual classification.

Classification

Constructed under dual classification, these ships will class ✠ 100-A-1 at Lloyd's Register of Shipping and ✠ A-1 [E] American Bureau of Shipping. The construction and equipment will also be in accordance with the Rules of the United States Supervising Inspectors of Steam Vessels.

Characteristics

The general particulars of these vessels, which will be of the type with machinery located amidships and one funnel, are as follows:

Length overall	356 feet 0 inches
Length between perpendiculars	340 feet 0 inches
Beam, molded	49 feet 0 inches
Depth, molded	28 feet 7½ inches
Load draft	24 feet 9 inches
Total deadweight	6,300 tons
Cubic capacity of all cargo spaces, exclusive of deep tank space, grain measurement	330,000 cubic feet
Fuel oil capacity	1,356 tons
Reserve feed water, double bottom	125 tons
Domestic fresh water	8,000 gallons
Sea speed	10½ knots
Indicated horsepower	2,000

Hull

The vessel will be built on the Isherwood system of longitudinal framing with a straight stem and semi-elliptical stern. It will have one complete steel deck, a short poop 33 feet long, a long bridge 221 feet long and extending over the engine and boiler casings, and a forecastle deck 30 feet long, all of steel construction.

Four steel, watertight, transverse bulkheads and three steel oiltight bulkheads will be fitted.

A cellular double bottom extending the entire length between the peak bulkheads will be fitted for the carriage of fuel oil, except under the engine space, where reserve feed water will be carried.

The fore peak tank will be used for the storage of fuel oil, and the after peak tank for reserve feed water.

Two steel deck houses will be erected on the bridge deck, one in way of the engine and boiler casings and one between No. 2 and 3 hatches, with quarters arranged as shown on the accompanying plans. A steel deck house to accommodate the captain's quarters will be erected on top of the forward bridge deck house, and above this a wooden pilot house will be built. Crew's quarters are provided in the poop.

Two steel masts, with telescopic wooden pole topmasts, and two king posts will be provided. The height of the masts, with topmasts housed, will be such as to enable the vessel to pass under the Manchester Canal bridges in light condition.

All rigging fittings, ventilation, etc., will be fitted in accordance with the best marine practice for a vessel of this type.

The vessel will be equipped with two 28-foot lifeboats located on the boat deck and one 16-foot motorboat located on the port side of the upper bridge.

Cargo Space

The forecastle has been designed for the stowage of cargo and boatswain's stores. The under deck space will be divided into four cargo holds and a deep tank. An oiltight centerline bulkhead will be fitted in the deep tank and provision made for the carriage of fuel oil or cargo. No. 3 'tween decks above the deep tank will also be used as cargo space.

Cargo Handling Gear and Deck Auxiliaries

Five 5-ton wooden or tubular cargo booms will be located at the mainmast and also at the foremast, and one 3-ton wooden cargo boom will be provided at each kingpost. The handling of lines and cargo hoists from the booms will be by means of five steam winches located at each mast and one winch at each kingpost.

A warping winch will be provided aft on the poop deck and a steam windlass forward on the forecastle deck.

Steam steering gear will be installed in the poop with telemotor connection to the pilot house.

Hatches

Access to the deep tank will be provided by two oiltight hatches, one being located each side of the centerline. Large cargo hatches will be located in way of each hold and to the bridge space as shown on the accompanying plans. A small hatch in the forecastle deck will provide access to the boatswain's storeroom, and a steel companionway will be erected on the poop deck for access to the crew's quarters.

Propelling Machinery

The main propelling machinery will consist of one triple expansion engine of the vertical, inverted, surface condensing type having cylinders 23 inches, 39 inches and 65

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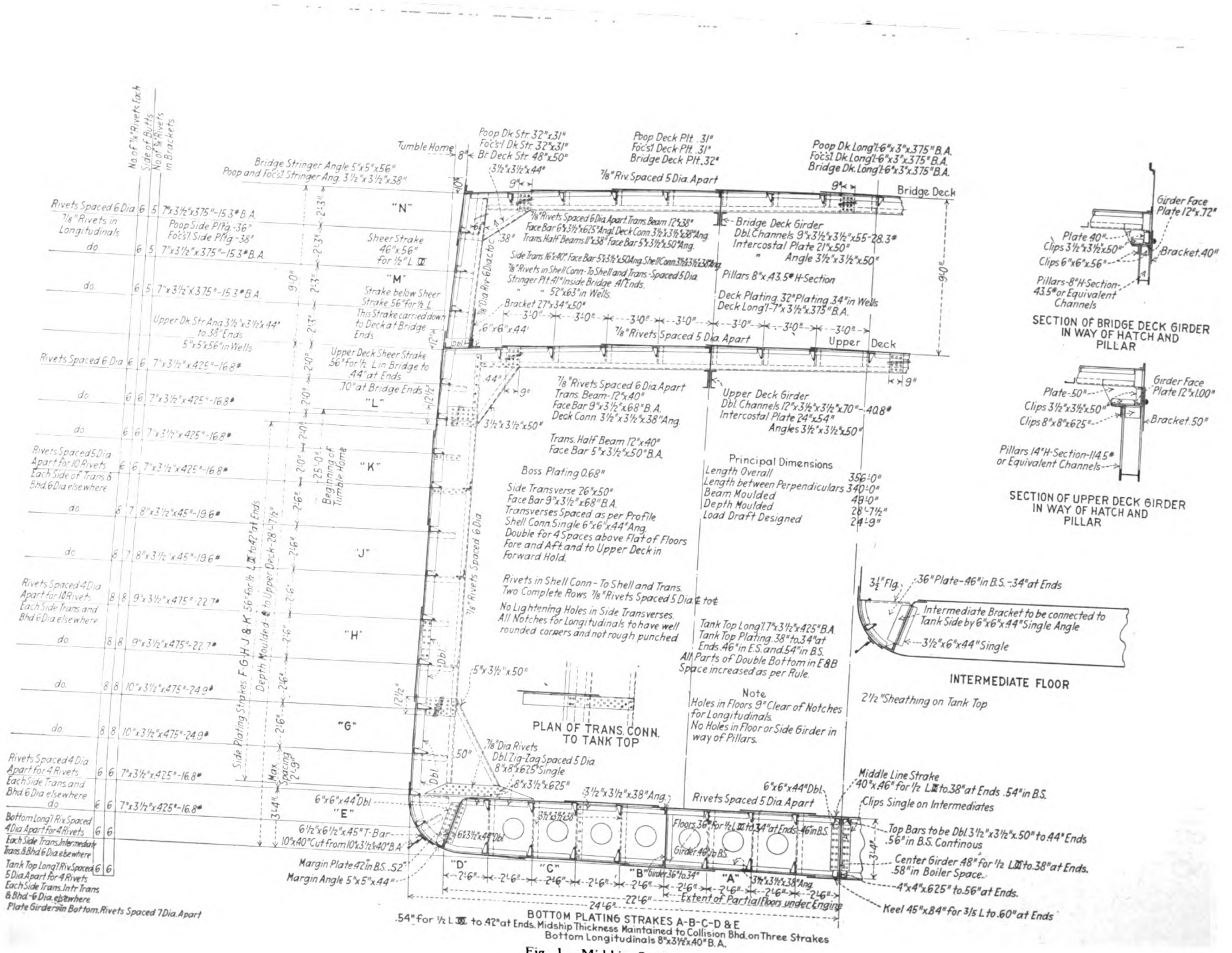
No. of 7/8" Rivets, Each Side of Butts
No. of 7/8" Rivets in Brackets
Tumble Home
Bridge Stringer Angle 5"x5"x56"
Poop and Fo'cs'l Stringer Ang. 3½"x3½"x.38"
Poop Dk Str. 32"x.31"
Fo'cs'l Dk Str. 32"x.31"
Br. Deck Str. 48"x.50"
Poop Deck Plt. .31"
Fo'cs'l Deck Plt. .31"
Bridge Deck Plt. .32"
Poop Dk. Long'l 6"x3"x.375" B.A.
Fo'cs'l Dk. Long'l 6"x3"x.375" B.A.
Bridge Dk. Long'l 6"x3"x.375" B.A.
7/8" Riv. Spaced 5 Dia. Apart
Bridge Deck
Bridge Deck Girder
Dbl. Channels 9"x3½"x3½"x.55-28.3#
Intercostal Plate 21"x.50"
" Angle 3½"x3½"x.50"
Pillars 8"x43.5# H-Section
Deck Plating .32" Plating .34" in Wells
Deck Long'l 7"x3½"x.375" B.A.
7/8" Rivets Spaced 5 Dia. Apart
Upper Deck
Upper Deck Girder
Dbl. Channels 12"x3½"x3½"x.70"-40.8#
Intercostal Plate 24"x.54"
Angles 3½"x3½"x.50"
Principal Dimensions
Length Overall 356'-0"
Length between Perpendiculars 340'-0"
Beam Moulded 48'-0"
Depth Moulded 28'-7½"
Load Draft Designed 24'-9"
Rivets Spaced 6 Dia.
7/8" Rivets Spaced 6 Dia. Apart Trans. Beam 12"x.38"
Face Bar 6"x3½"x.625" Angl. Deck Conn. 3½"x3½"x.38" Ang.
Trans. Half Beams 11"x.38" Face Bar 5"x3½"x.50" Ang.
Side Trans. 16"x.40" Face Bar 5"x3½"x.50" Ang. Shell Conn. 3½"x3½"x.38" Ang.
7/8" Rivets in Shell Conn - To Shell and Trans. - Spaced 5 Dia.
Stringer Plt. 41" Inside Bridge .41" Ends.
" 52"x63" in Wells.
Bracket 27"x34"x.50"
7/8" Dia. Rivets 6 Dia. Apart
6"x6"x.44"
3½"x3½"x.50"
7/8" Rivets Spaced 6 Dia. Apart
Trans. Beam - 12"x.40"
Face Bar 9"x3½"x.68" B.A.
Deck Conn. 3½"x3½"x.38" Ang.
Trans. Half Beam 12"x.40"
Face Bar 5"x3½"x.50" B.A.
Boss Plating 0.68"
Side Transverse 26"x.50"
Face Bar 9"x3½"x.68" B.A.
Transverses Spaced as per Profile
Shell Conn. Single 6"x6"x.44" Ang.
Double for 4 Spaces above Flat of Floors
Fore and Aft and to Upper Deck in
Forward Hold.
Rivets in Shell Conn - To Shell and Trans.
Two Complete Rows 7/8" Rivets Spaced 5 Dia. c to c
No Lightening Holes in Side Transverses.
All Notches for Longitudinals to have well
rounded corners and not rough punched
Tank Top Long'l 7"x3½"x.425" B.A.
Tank Top Plating .38" to .34" at
Ends .46" in E.S. and .54" in B.S.
All Parts of Double Bottom in E & B
Space increased as per Rule.
Note
Holes in Floors 9" Clear of Notches
for Longitudinals.
No Holes in Floor or Side Girder in
way of Pillars.
Rivets Spaced 6 Dia.
Rivets Spaced 5 Dia. Apart for 10 Rivets Each Side of Trans. & Bhd. 6 Dia elsewhere
Rivets Spaced 4 Dia. Apart for 10 Rivets Each Side Trans. and Bhd. 6 Dia elsewhere
Rivets Spaced 4 Dia. Apart for 4 Rivets Each Side Trans. and Bhd. 6 Dia elsewhere
Bottom Long'l Riv. Spaced 4 Dia. Apart for 4 Rivets Each Side Trans. Intermediate Trans. & Bhd. 6 Dia elsewhere
Tank Top Long'l Riv. Spaced 5 Dia. Apart for 4 Rivets Each Side Trans. Intr. Trans. & Bhd. 6 Dia. elsewhere
Plate Girder in Bottom. Rivets Spaced 7 Dia. Apart
Upper Dk. Str. Ang. 3½"x3½"x.44" to .38" Ends
5"x5"x.56" in Wells
Sheer Strake 46"x.56" for ½" L
Strake below Sheer Strake 56" for ½" L
This Strake carried down to Deck at Bridge Ends
Upper Deck Sheer Strake .56" for ½ L in Bridge to .44" at Ends .70" at Bridge Ends
Beginning of Tumble Home
Side Plating Strakes F, G, H, J & K .56" for ½ L to .42" at Ends
Depth Moulded to Upper Deck - 28'-7½"
Max. Spacing 2'-9"
"N"
"M"
"L"
"K"
"J"
"H"
"G"
"E"
"D"
"C"
"B" Girder .36" to .34"
"A"
6"x6"x.44" Dbl.
6½"x6½"x.45" T-Bar
10"x40" Cut from 10"x3½"x.40" B.A.
Margin Plate 42" in B.S. .52"
Margin Angle 5"x5"x.44"
PLAN OF TRANS. CONN. TO TANK TOP
7/8" Dia. Rivets
Dbl. Zig-Zag Spaced 5 Dia.
8"x8"x.625" Single
8"x3½"x.625"
3½"x3½"x.38" Ang.
6"x6"x.44" Dbl.
Rivets Spaced 5 Dia. Apart
Floors 36" for ½ L to .34" at Ends .46" in B.S.
Girder 48" for B.S.
Middle Line Strake
40"x.46" for ½ L to .38" at Ends .54" in B.S.
Clips Single on Intermediates
Top Bars to be Dbl. 3½"x3½"x.50" to .44" Ends
.56" in B.S. Continous
Center Girder 48" for ½ L to .38" at Ends.
.58" in Boiler Space.
4"x4"x.625" to .56" at Ends.
Keel 45"x.84" for 3/s L to .60" at Ends
Extent of Partial Floors under Engine
24'-6"
22'-6"
2'-6"
BOTTOM PLATING STRAKES A-B-C-D & E
.54" for ½ L to .42" at Ends. Midship Thickness Maintained to Collision Bhd. on Three Strakes
Bottom Longitudinals 8"x3½"x.40" B.A.
Girder Face Plate 12"x.72"
Plate .40"
Clips 3½"x3½"x.50"
Clips 6"x6"x.56"
Bracket .40"
Pillars 8" H-Section 43.5# or Equivalent Channels
SECTION OF BRIDGE DECK GIRDER IN WAY OF HATCH AND PILLAR
Girder Face Plate 12"x1.00"
Plate .50"
Clips 3½"x3½"x.50"
Clips 8"x8"x.625"
Bracket .50"
Pillars 14" H-Section-114.5# or Equivalent Channels
SECTION OF UPPER DECK GIRDER IN WAY OF HATCH AND PILLAR
3½" Flg.
.36" Plate - .46" in B.S. - .34" at Ends
Intermediate Bracket to be connected to Tank Side by 6"x6"x.44" Single Angle
3½"x6"x.44" Single
INTERMEDIATE FLOOR
2½" Sheathing on Tank Top

Fig. 1.—Midship Section

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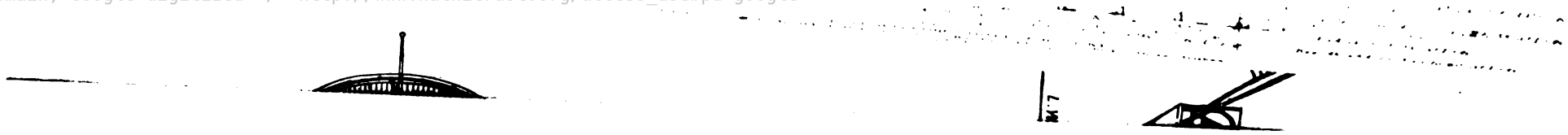

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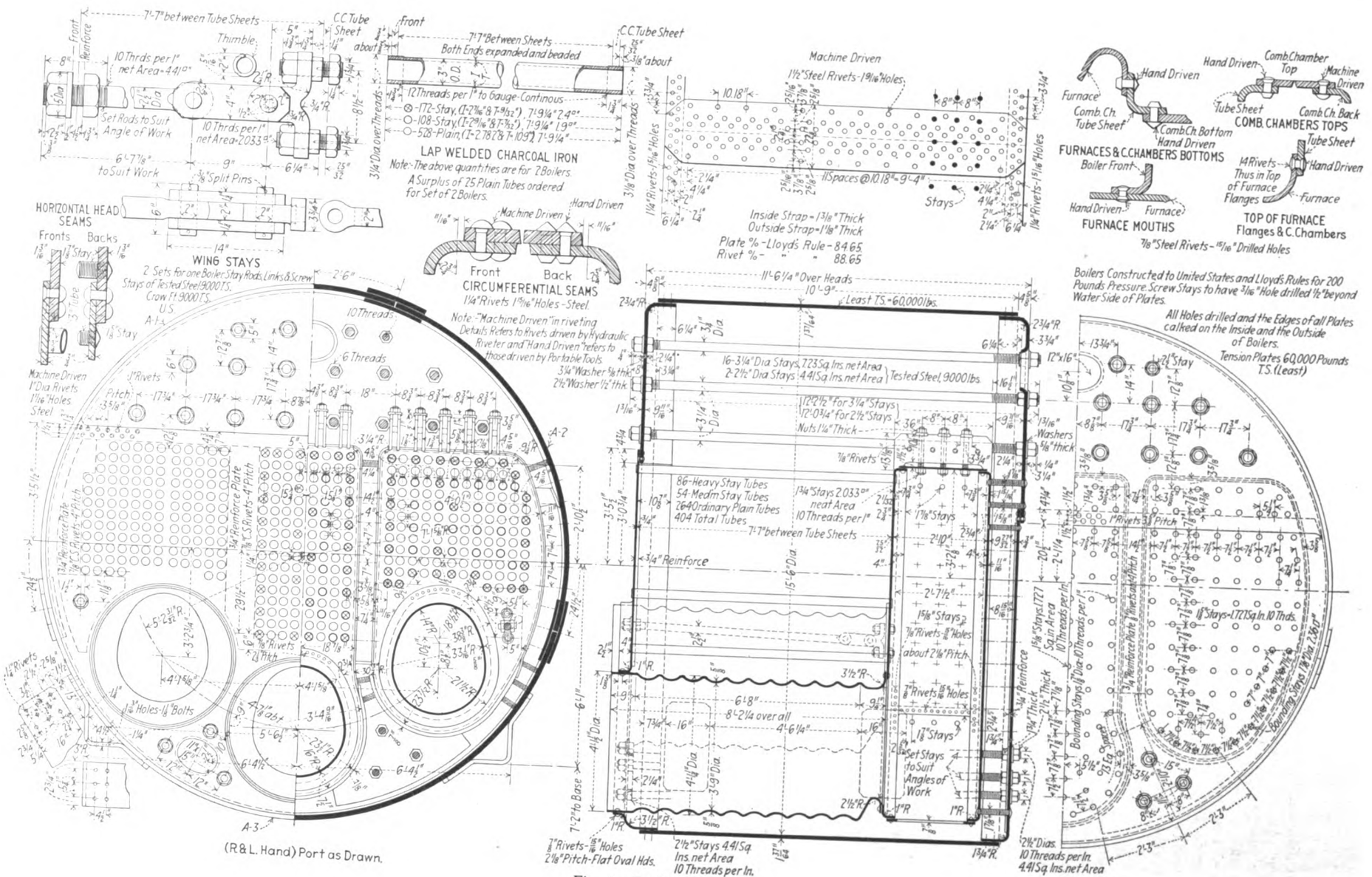
LAP WELDED CHARCOAL IRON
CIRCUMFERENTIAL SEAMS
WING STAYS
HORIZONTAL HEAD SEAMS
COMB. CHAMBERS TOPS
FURNACES & C.CHAMBERS BOTTOMS
FURNACE MOUTHS
TOP OF FURNACE Flanges & C.Chambers
Boilers Constructed to United States and Lloyd's Rules for 200 Pounds Pressure Screw Stays to have 3/16" Hole drilled 1/2" beyond Water Side of Plates.
All Holes drilled and the Edges of all Plates calked on the Inside and the Outside of Boilers.
Tension Plates 60,000 Pounds T.S. (least)
(R & L. Hand) Port as Drawn.

Fig. 4.—Details of Boiler

inches in diameter by 42 inches stroke. At 200 pounds boiler gage pressure the engine will indicate about 2,000 indicated horsepower at 84 revolutions per minute under normal conditions without live steam in the receiver. The air pump, two feed pumps, two bilge pumps and an evaporator feed pump will be attached to the main engine. A main condenser independent of the main engine framing will be provided.

BOILERS

The boilers will be of the Scotch type, built for a working pressure of 200 pounds and fitted with the Howden heated forced draft system. There will be two single ended boilers having an inside diameter of 15 feet 6 inches and a mean length of 11 feet 5¾ inches. Each boiler will be fitted with three 45-inch Morison furnaces and with separate combustion chambers. The boilers will be fitted for oil burning, but arrangements will also be made for available coal bunkers and necessary boiler fittings furnished so that the vessel can be quickly converted into a coal burner when so desired.

The shell plating of the boilers is 1 37/64 inches in thickness, of steel having a tensile strength of at least 60,000 pounds per square inch. Inside and outside butt straps are used on the longitudinal seams, the inner strap of 1⅜-inch plate and the outside strap 1⅛ inches thick. To obtain the tube heating surface of 2,852 square feet and the proper staying of the tube sheets, each boiler is fitted with 404 tubes, of which 86 are heavy stay tubes, 54 medium stay tubes, and 264 ordinary tubes 3 inches outside diameter and 7 feet 7 inches long between tube sheets. These tubes are of lap welded charcoal iron. Sixteen 3¼-inch diameter and two 2½-inch diameter long through stays tested to 9,000 pounds are provided for staying the front and back heads.

REQUIREMENTS FOR MACHINERY INSTALLATION

Both the boilers and propelling machinery will meet all the requirements of the United States Steamboat Inspection Service, Lloyd's Register of Shipping and the American Bureau of Shipping.

Design data and a comparison of the relative maximum

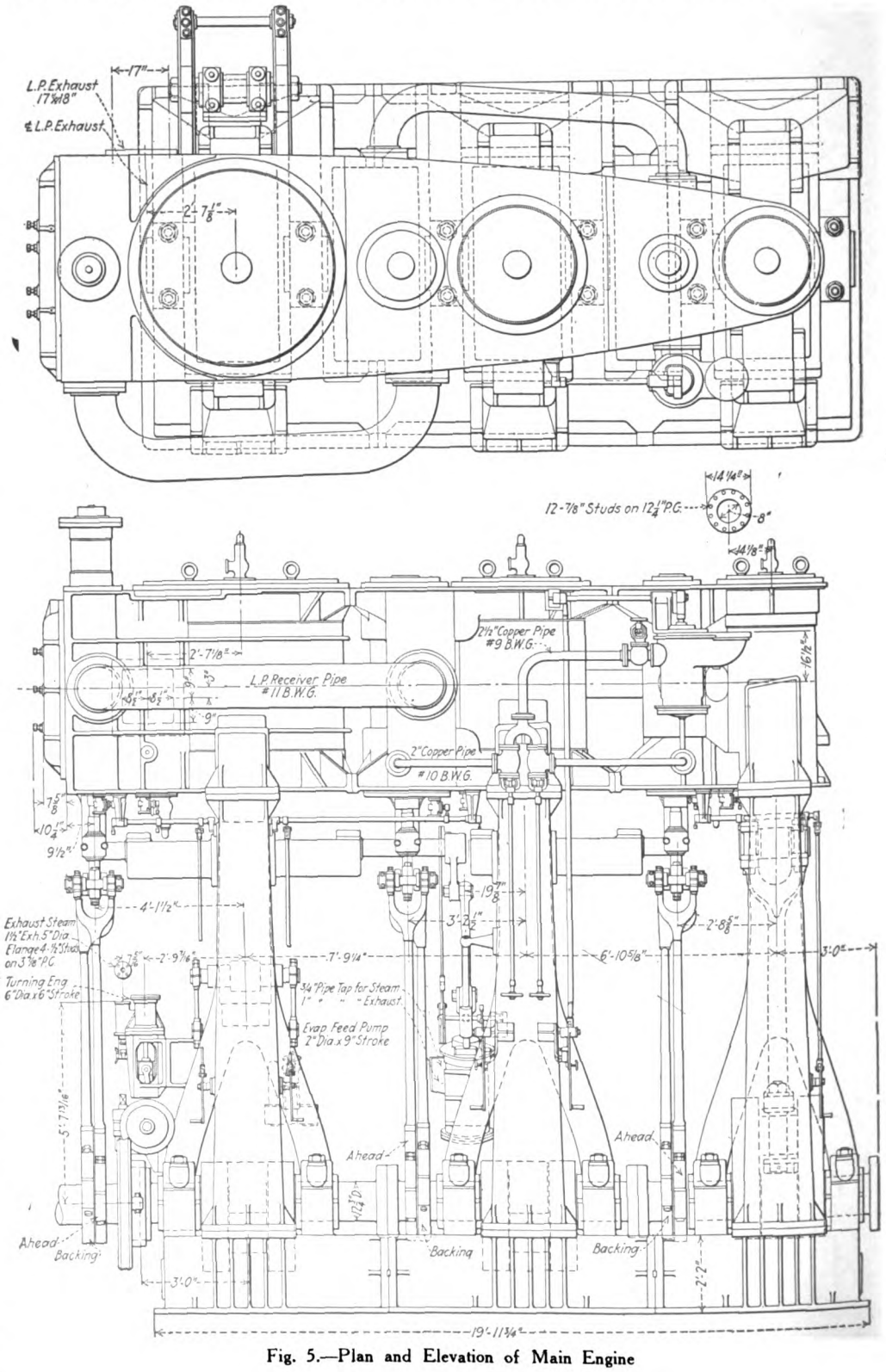

Fig. 5.—Plan and Elevation of Main Engine

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value of parts for the boilers are contained in Tables 1 and 2, which follow:

TABLE 1

Data	One Boiler	Two Boilers
Working pressure per square inch, pounds above atmosphere	200	200
Hydrostatic pressure per square inch, pounds above atmosphere	300	300
Heating surface, tubes, square feet	2,406	4,812
Heating surface, furnaces, square feet	140	280
Heating surface, combustion chambers, square feet	306	612
Heating surface, total, square feet	2,852	5,704
Grate surface, 6 feet oil burning, square feet	67.5	135
Ratio heating surface to grate surface	42¼	42¼
Calorimeter, area through tubes, square feet	15.9	31.8
Ratio grate surface to calorimeter	4.24	4.24
Estimated evaporation of water per pound of oil, pounds	13½	13½
Estimated evaporation per square foot of grate, pounds	202½	202½
Estimated evaporation per hour, pounds	13,669	27,338
Estimated oil consumption per square foot of grate, pounds	15	15
Estimated oil consumption per hour	1,012½	2,025
Safety valve, area per United States rules, square inches	13.18	13.18
Safety valve, actually supplied, 3½-inch twin, square inches	19.24	19.24
Steam space, 8 inches above combustion chamber top, cubic feet	410	820
Estimated weight of water, 8 inches above combustion chamber top, pounds	61,800	123,600
Estimated weight bare boiler, tons (2,240 pounds)	50.7	101.4

TABLE 2.—RELATIVE MAXIMUM VALUES OF PARTS

Part	U. S. Rules, Pounds	Lloyd's Rules, Pounds
Shell	203	223
Longitudinal shell joint	...	223
Inside strap, percent shell plate	...	87
Top heads	200	200
Front bottom heads (above middle furnace)	270	225
Front bottom heads (between tube nests)	261	215
Rear bottom heads	270	225
*Rear bottom heads (¾-inch reinforced)	265	238
Combustion chamber girders	210	235
Combustion chamber top plates	232	232
Combustion side plates	257	214
Combustion chamber bottom plates	204	233
Combustion chamber tube sheet	205	217
Combustion chamber back sheet	241	201
Furnaces	207	204
Inner stay tubes	281	351
Outer stay tubes	203	254
Upper main stays, 3¼ inches	206	238
Upper main stays, 2½ inches	236	272
Wing stays, 2½ inches	254	293
Bottom stays, 2½ inches	226	261
Screw stays, 1⅞ inches bounding	244	244
Screw stays, 1¾ inches, girders	261	261
Screw stays, 1¾ inches, wings	217	217
Screw stays, 1⅝ inches, combustion chamber sides	277	277
Screw stays, 1⅝ inches, combustion chamber back	259	259

* 265 pounds for bottom reinforce; 238 pounds for reinforce between stays.

A glance at the arrangement plans accompanying this article will bring out many features of particular interest. Among the most important may be noted the following principal advantages:

The vessel is well adapted to the carriage of bulk cargoes such as coal, grain, etc., as well as the ordinary type of general cargo. The holds are each of almost equal capacity, insuring equal time for loading or unloading each compartment. This results in a more equal distribution of loads upon the ship's winches and gear and insures that the vessel will not be held at the wharf unloading one large hold after the other smaller holds have been completely discharged.

The upper deck is supported by continuous girders at

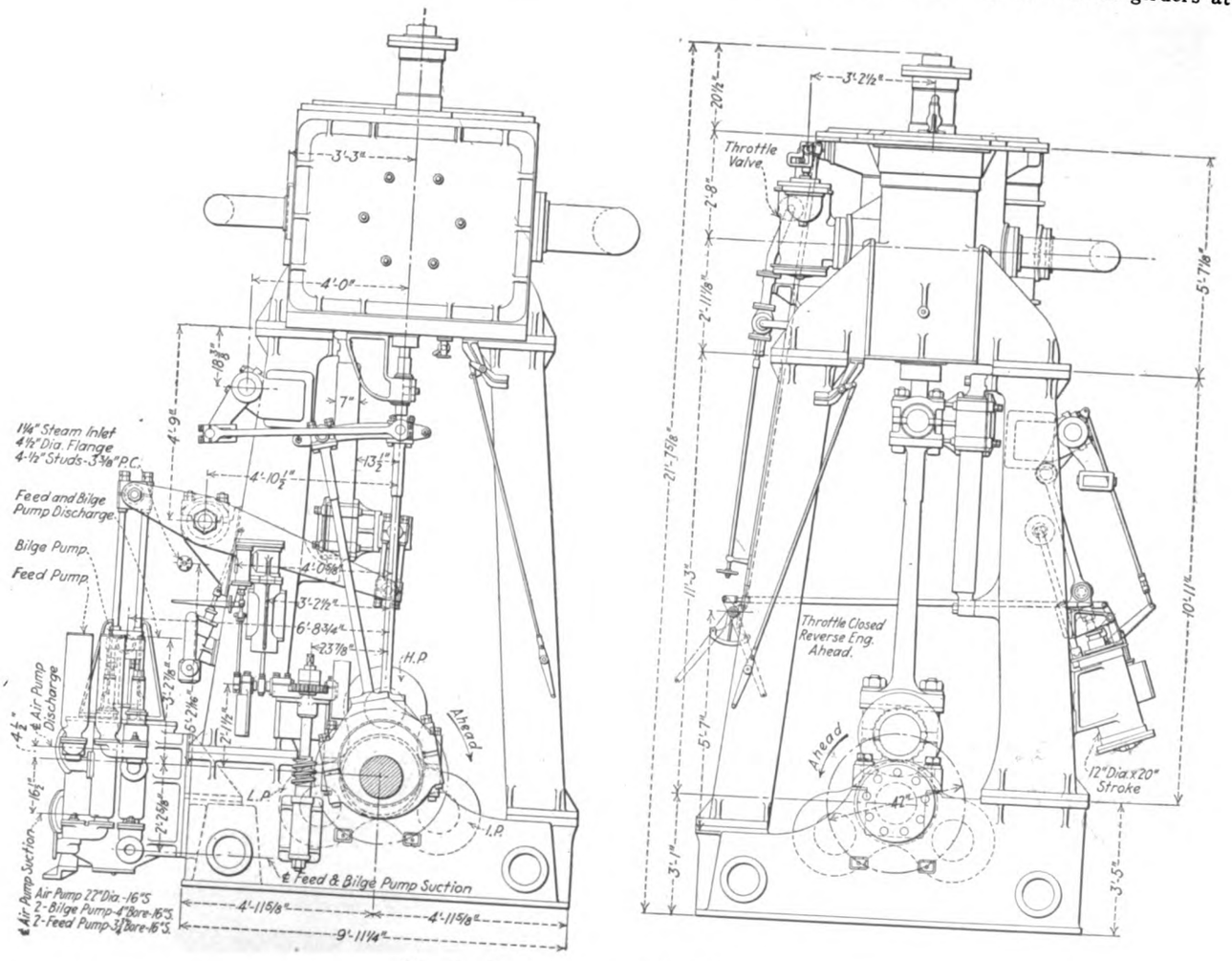

Fig. 6.—End Elevations of Main Engine

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hatch sides with one pillar at the center of each hatch side on each girder. Thus each hold has only two pillars and is remarkably free for stowage and handling of cargo.

The hatches are of a capacity sufficient to insure carriage of grain without necessity for bagging. Wood portable shifting boards can be fitted as a centerline bulkhead when grain is carried.

A height of 9 feet has been provided in the long bridge space to permit the stowage of cotton bales three high. The ordinary deck height allows tiering cotton only two bales high with a corresponding large waste of space for the carrying of cargo.

The arrangement of five booms and winches at each mast has been adopted to facilitate loading or unloading the vessel from both sides simultaneously when desired. On this account the middle winch at each mast is of the double independent drum type.

Tonnage openings have been fitted to the bridge space and forecastle for maximum tonnage exemption.

The large fuel oil capacity provides a cruising radius of about 12,000 miles at 10½ knots loaded. Also in case the owners wish to burn coal at any time, part of the bridge space, No. 3 'tween deck space and side coal pockets can all be utilized for bunkers without any alteration to the ship's structure.

Particular attention has been given to the arrangement of quarters throughout the vessel, with especial regard to maximum amount of light, ventilation and comfort.

Particular attention has also been given to the design of the hull form and the propeller, resulting in an unusually easy vessel to drive.

The first vessel to be built in the United States from this design is now under construction, and the results of the trial trip and early service trips will be eagerly awaited.

Electric Propelling Unit of the Eclipse

First General Cargo Merchant Vessel in the United States to Be Equipped with Electric Drive

THE original plan of the United States Shipping Board at the peak of its war activities was to build twenty-five ships of the general cargo type to be equipped with electric drive. At the time of the armistice practically all construction work on these ships was suspended together with orders on file with the General Electric Company for the electric propelling units. The cancellation of the ship construction was possible, for work had progressed to only a slight degree at that time, but in the case of the electrical machinery cancellation was not possible without an extravagant waste of useable material, so the United States Shipping Board finally decided to accept ten of the units which might be installed in such of the ships under its present control as would be best adapted for electrical drive. It was hoped in this way to prove the value and economy of this type of propulsion when used on commercial carriers.

Geared Turbines Originally Installed

The *Eclipse* was built by the Union Iron Works, of San Francisco, Cal., during the year 1918 and was originally engined with General Electric Curtis turbines driven through General Electric reduction gears. She is a vessel of 11,868 deadweight tons, 440 feet long, with a beam of 56 feet. The present electric machinery was produced by the General Electric Company, Schenectady, N. Y., and installed by the Vulcan Iron Works, of Jersey City, N. J.

The history of electric propulsion in ships of the Navy is well known to naval architects and marine engineers in general, and the success of the electric installations in the collier *Jupiter* and in the battleships *New Mexico* and *Tennessee* indicated the possibilities of electrically propelling ships in general.

New Development for Merchant Ships

Since the electrification of the *Eclipse,* however, is a complete and new venture in driving large tonnage merchant vessels by electricity, the equipment installed upon the battleships cannot well be cited as a criterion for propulsion on a vessel of this type, since its speed is lower than that of the Navy vessels and the application in general of electrical equipment is quite different.

Bearing in mind that merchantmen are constant speed rather than variable speed vessels, it can readily be seen that the most advantageous use of electricity in propelling this type of vessel would be a powerful but slow speed motor, the initial cost of which should be a minimum.

For this reason a 3,000 horsepower, 2,300 volt, three phase, 50 cycle, 60 pole, 100 revolutions per minute induction motor of the phase wound rotor type directly connected to the propeller shaft is used to furnish the propelling power of the *Eclipse.* This motor receives its cur-

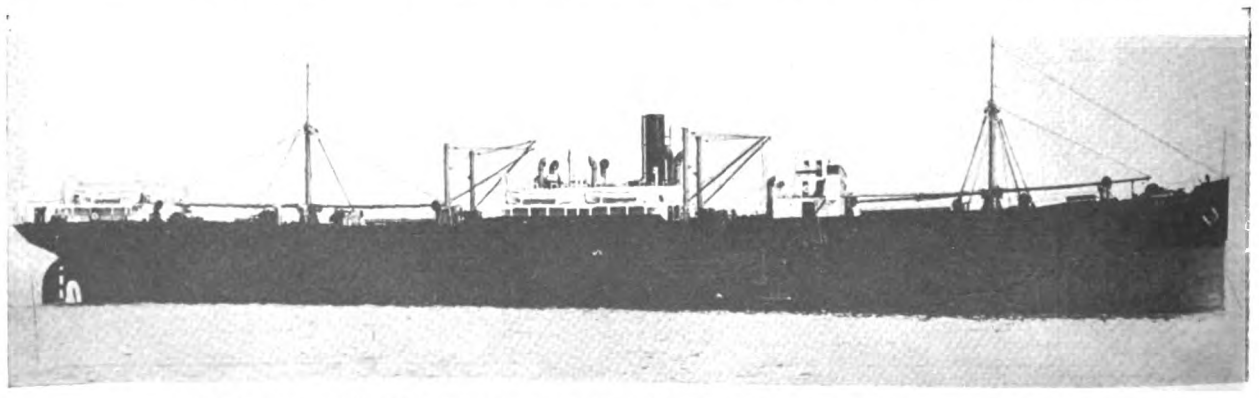

Fig. 1.—S. S. *Eclipse,* the First American Cargo Vessel to Be Equipped With Electric Drive

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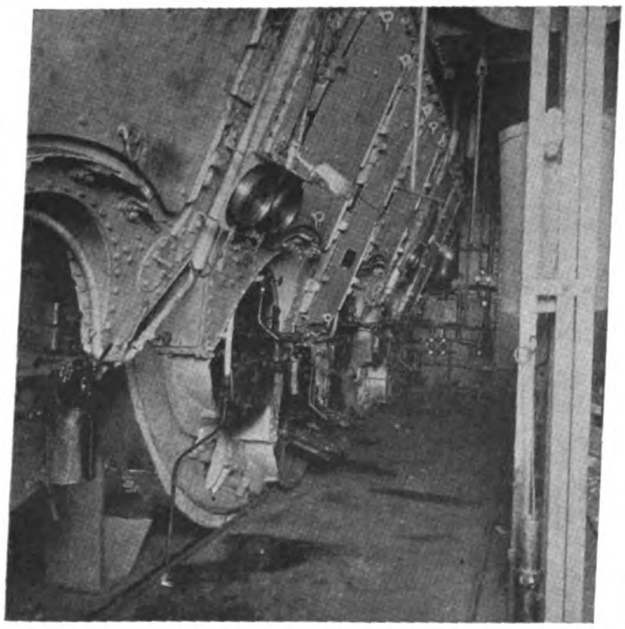

Fig. 2.—General View of Boiler Room, Showing Dahl System for Burning Fuel Oil

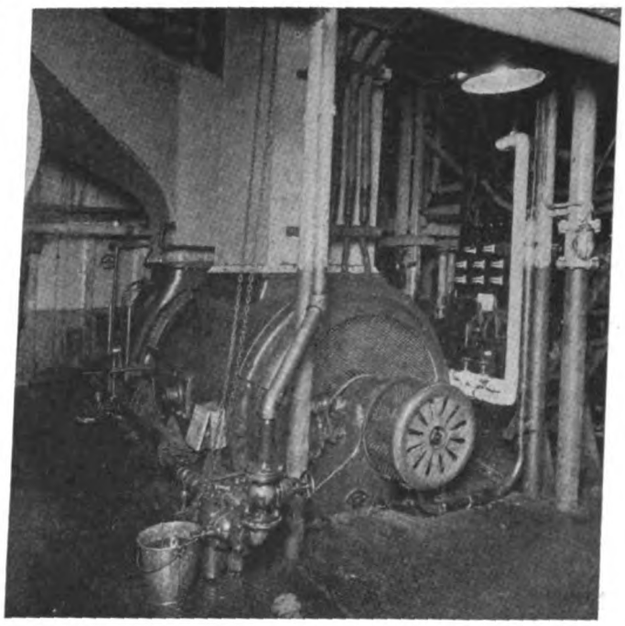

Fig. 3.—3,000-Kilowatt Turbo Generator, Showing Exhaust Pipe to Condenser and Ventilating Hood

rent from a 3,100 horsepower, 2,300 volt, 3 phase, 50 cycle, 2 pole turbo generator whose maximum speed when delivering 2,300 volts at 50 cycles with normal excitation is 3,000 revolutions per minute. Both the generator and motor have been designed especially for sea duty and are provided with non-corrodible fittings, extra high voltage insulation and all windings impregnated against heat resistance and salt water atmospheric conditions. There are also two steam engine driven, 125 volt, direct current exciters and a control equipment for maneuvering the ship.

In detail the turbine is of the horizontal Curtis type operating normally, as noted above, at 3,000 revolutions per minute and is of the type developed specially for marine purposes. The governing system is so arranged that the turbine is controlled by a hydraulic variable speed governor at speeds from 20 to 110 percent of normal. It is further provided with protective devices in the way of a centrifugal type pre-emergency governor controlling the speed up to 15 percent of normal and a ring type emergency governor which prevents the turbine from running at speeds exceeding 125 percent of normal.

The three phase generator of 2,300 volts is especially designed for marine service in conjunction with the turbine unit. It incorporates several features necessary to

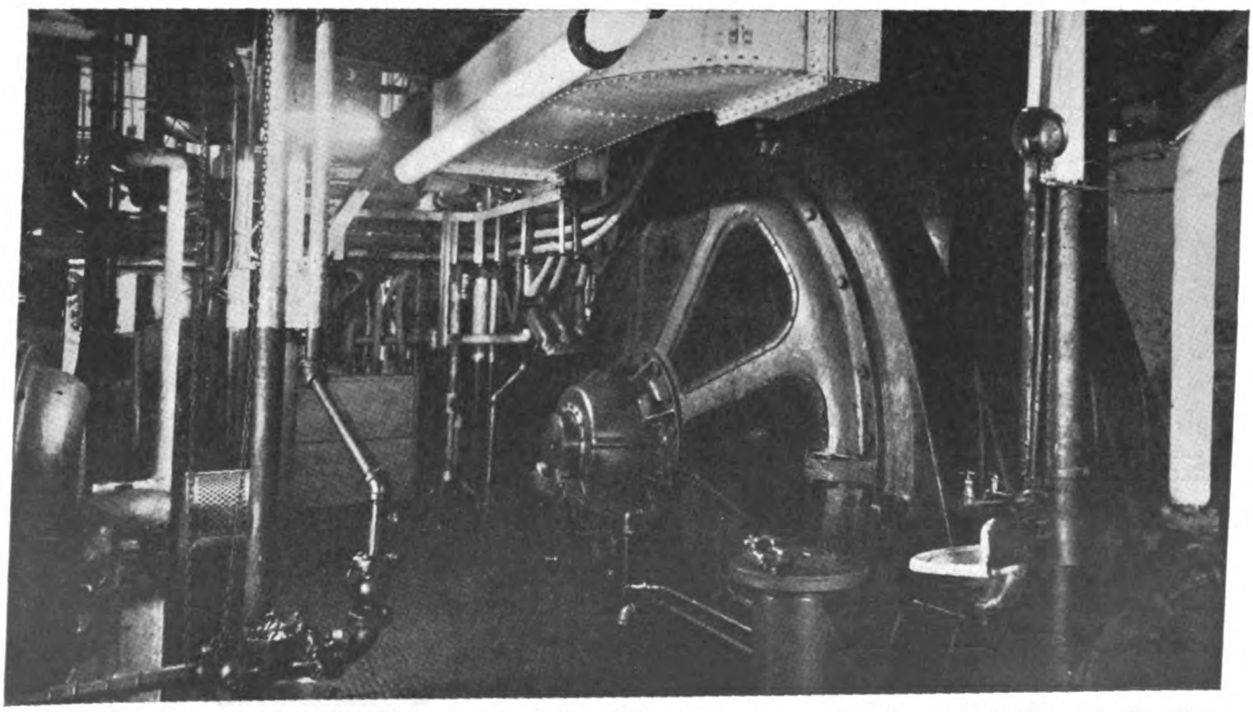

Fig. 4.—3,000-Horsepower, 2,300-Volt, 3-Phase, 50-Cycle Induction Motor of Phase-Wound Rotor Type, Directly Connected to Propeller Shaft

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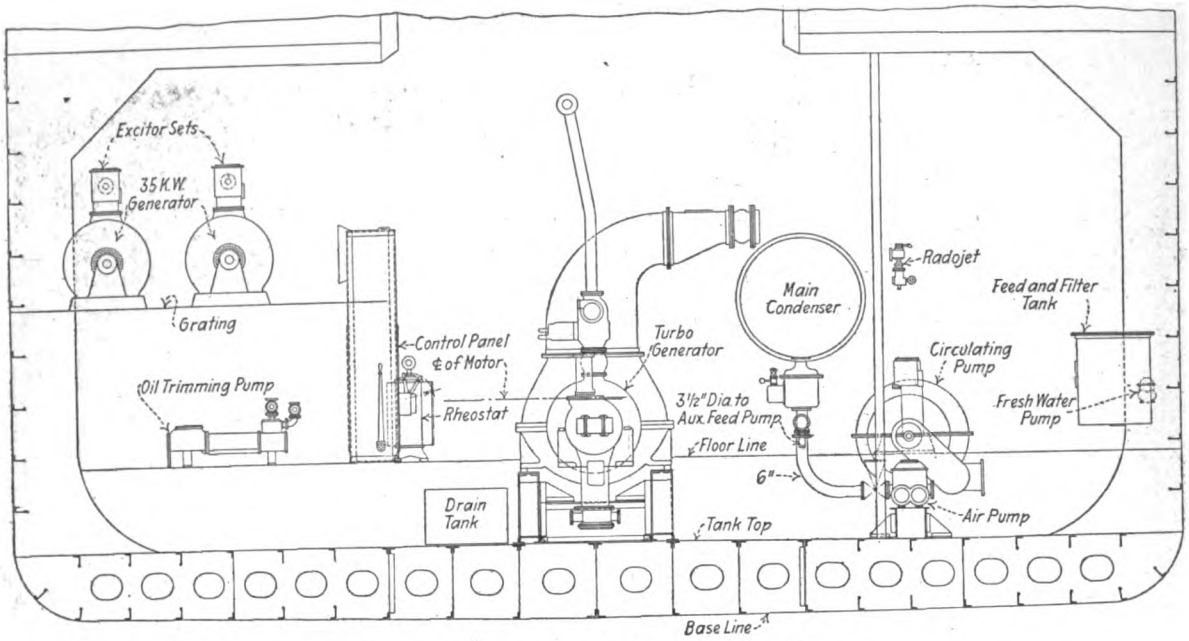

Fig. 5.—Transverse Section Through Engine Room

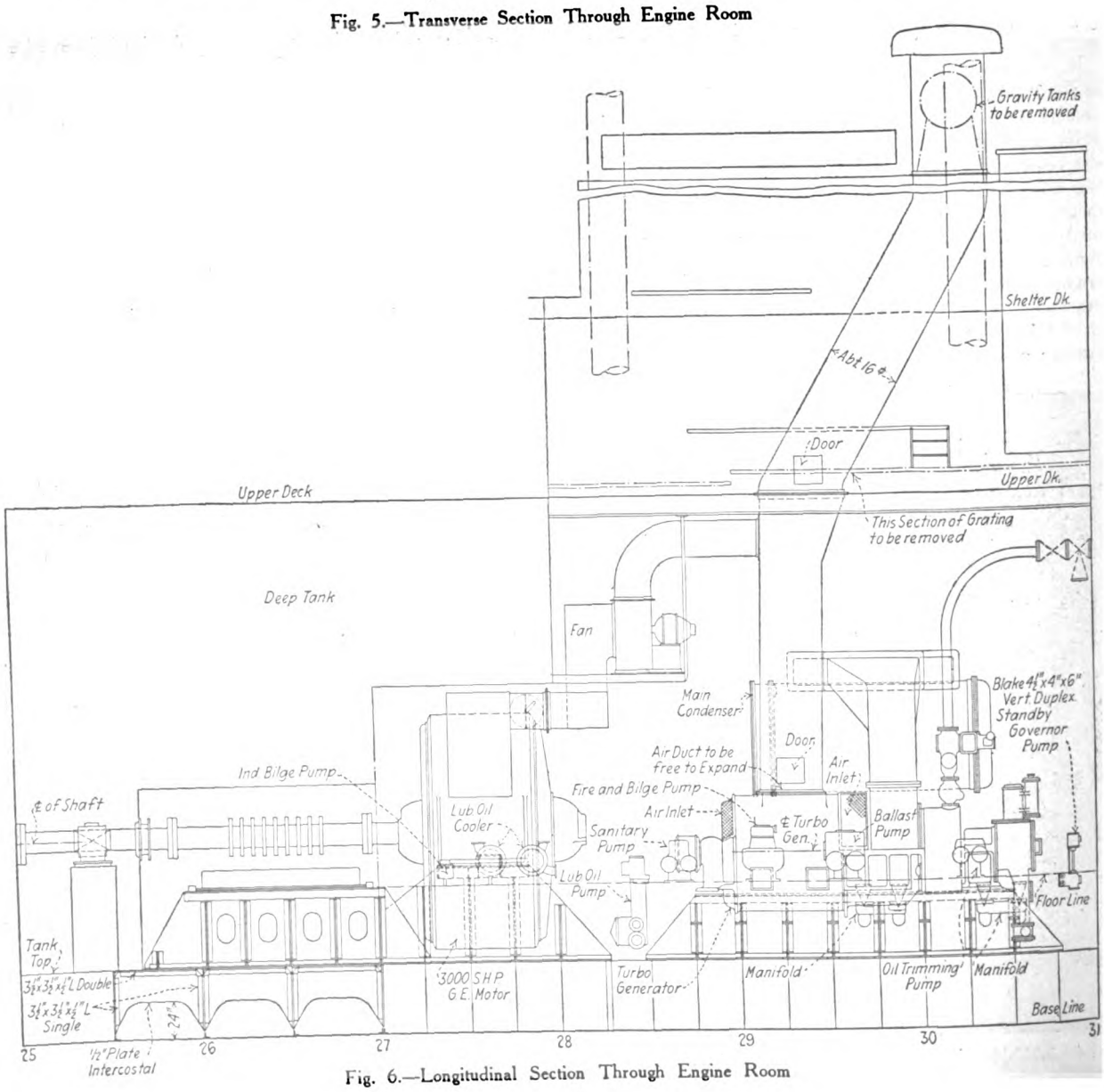

Fig. 6.—Longitudinal Section Through Engine Room

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meet the particular requirements of propulsion in a merchant vessel. The stator consists of a cast iron, one-piece frame with openings in the top for ventilation, while the core is built up of annealed segments of thin sheet iron of special material to insure a low core loss. It is held in place by heavy cast iron frame flanges at each end.

The windings are formed coils pressed from enamelled cable, each turn consisting of rectangular strips in multiple. Eddy currents are eliminated by the strips being well insulated from each other. Ventilation is provided by a centrifugal fan mounted at each end of the rotor.

The propelling motor is an induction motor rated at 3,000 horsepower and revolves at a normal speed of 100 revolutions per minute, which gives a total reduction from the turbine to the propeller speed of 30 to 1. The motor is ventilated by a motor-driven blower. Attention is called to the fact that as this machine, in the true sense of the word, may be considered a constant speed motor, in lieu of its windings being fixed for 60 volt and three phase current, it is therefore used in the absence of pole-change winding and double squirrel cage rotor features for variable speeds.

The control equipment consists of a control group, a water cooled resistor and a control panel. The water cooled resistor is inserted in the motor circuit when operating at low speeds and is mounted on top of the control panel. The panel is a structural iron cell faced on one side by a sheet steel plate upon which are mounted all the electrical instruments and the electric and speed lever controllers for the normal operation of the machinery. The two levers are mechanically interlocked to prevent improper starting and running conditions. The electric lever moves a master controller, which in turn energizes the contactors of the control group.

SPEED REGULATION

Speed regulations for maneuvering the *Eclipse* are governed by a combination of inserted resistance in the phase-wound rotor, together with varying speeds of the turbine whereby both voltage and frequency of the current supplied to its stator windings form a function of the motor's torque and revolutions per minute.

In addition to the speed and electric levers there is a field resistor for regulating the generator field resistance

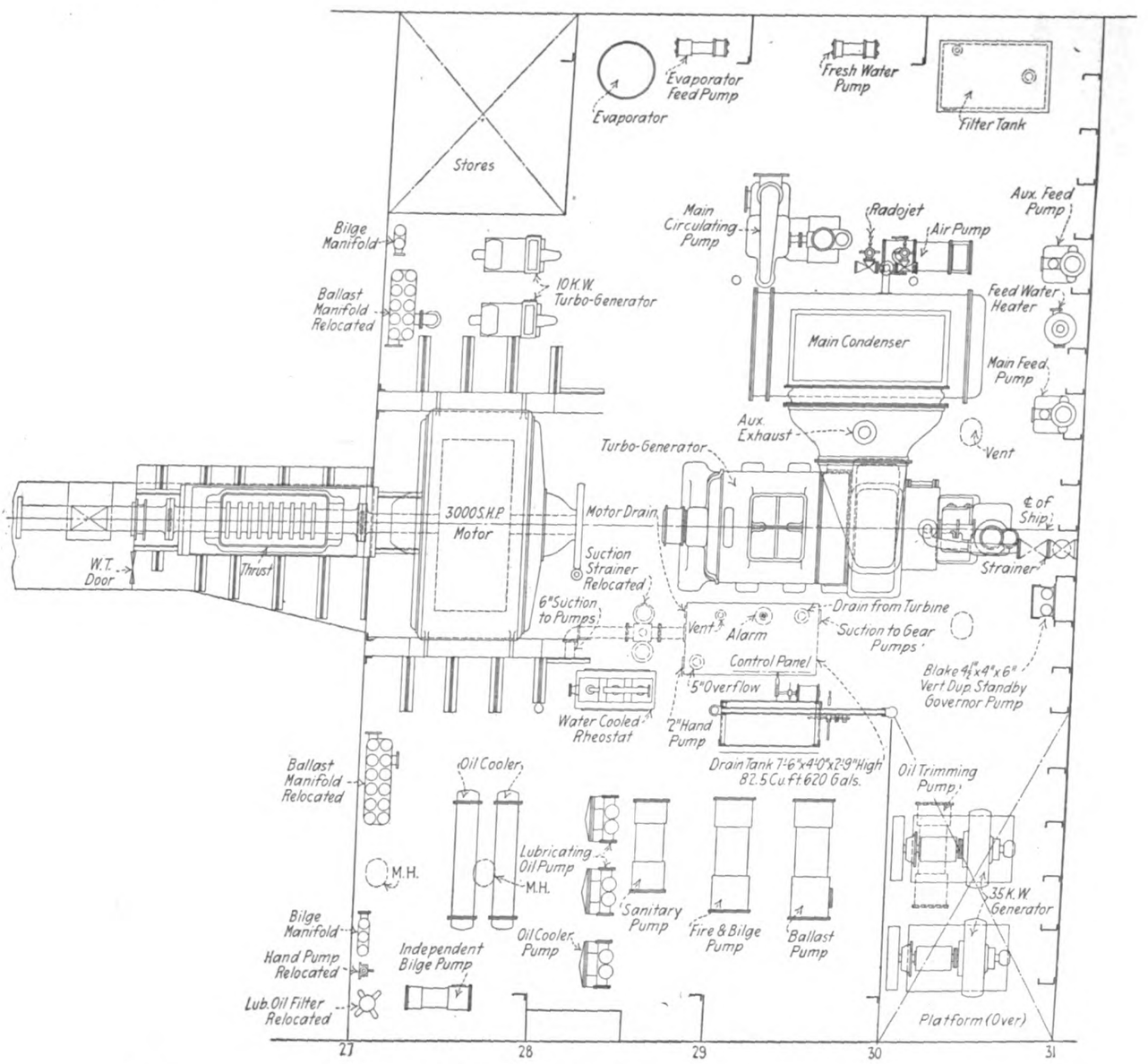

Fig. 7.—Plan of Engine Room

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Table 1.—DATA ON SEA TRIAL OF S. S. ECLIPSE—October 2, 1920

Hour	Kilowatt Generator	Gen. Field Temp.	Gen. Field Amp.	Volts	Turbine Speed	Excitation	Generator Amperes	Propeller Speed	Excitation Volts	Amperes Exciter	Throttle Pres. Pound per sq. in.	Vacuum Press. Inches Mercury	Boiler Stm. Press. Pounds per sq. in.	Lub. Oil Press.	Cir. Water Press.	Deck Stm. Press.	Throttle Ahead	Superheaters: Boiler 1	Superheaters: Boiler 2	Superheaters: Boiler 3	Oil Gages (Bhd.): Throttle 4	Oil Gages (Bhd.): Thrust Bear. 1	Oil Gages (Bhd.): Bear. Oil 2	Oil Gages (Bhd.): Hyd. Gear. 3	Oil Gages (Bhd.): Gov. 4	Oil Gages Turb.Gen.: Bear. 1	Oil Gages Turb.Gen.: Bear. 2	Oil Gages Turb.Gen.: Bear. 3	Oil Gages Turb.Gen.: Bear. Aft 4	Temp. Cir. Water Disch.	Temp. Turb. Exh.	Temp. Feed Water	Press. Feed Water	Temp. Cooling Water at Rheos.	Lub. Oil Press.	Temp. Lub. Oil After Cooler	Temp. Lub. Oil Before Cooler	Temp. Lub. Oil Cooling Water	Fuel Oil Press.	Fuel Oil Temp.
8:30	1950	...	...	2300	950	...	...	...	...	...	205	28¼	215	47	9	125	0	...	430	480	420	10½	10½	72	7½	12½	9	12½	5½	...	115	208	7½	C-G	18	83	87	68	...	...
9:10	1950	100	140	2300	3000	...	700	95	...	...	185	27	193	44	9	125	176	...	540	540	540	10	10½	87	6¾	12	9	12	5½	101	115	200	7½	20	18	85	89	68	175	220
9:30	1500	100	140	2000	2700	6	650	85	120	190	189	28	184	43	9	125	193	...	540	500	500	10¼	10¼	79	6¾	12	9	12	5½	91	115	200	4½	20	18	85	89	68	180	225
10:00	1200	110	125	1375	2475	6½	575	79	120	180	189	28½	195	47	9	125	110	...	550	550	540	10¼	10¼	86	6¾	12	9	12	6	86	115	215	7½	21	19	89	93	68	200	270
10:30	1600	130	155	2200	2800	6½	650	87	120	190	177	28	179	46	9	125	135	...	515	490	490	10¼	10¼	84	6¾	12	9	12	6	98	115	235	10½	20	18	90	96	68	185	248
11:00	1400	125	125	1750	2550	4¾	750	83	120	190	181	28¼	186	47	9	125	150	...	550	540	515	10¼	10¼	85	6¾	12	9	12	6	81	115	225	15	17	19	89	95	63	200	260
11:30	1800	125	130	1900	3000	5	700	95	130	190	178	27½	185	47	9	125	171	...	520	505	530	10¼	10¼	82	6¾	12	9	12	6	93	115	235	14	19	19	90	96	64	165	250
12:00	1200	120	115	1500	2400	3½	575	75	120	170	201	28½	210	47	9	125	150	...	540	530	530	10¼	10½	8..	6¾	12	9	12	6	87	115	225	14	19	19	89	95	65	215	225
12:30	1000	140	145	2100	2850	6	650	90	120	195	194	28	200	47	9	125	190	...	530	520	530	10½	10½	85	6¾	12	9	12	6	90	115	220	10	19	19	89	96	65	200	210
1:00	1050	140	190	2500	3000	6	700	95	120	240	196	28	205	47	9	125	195	...	560	560	560	10½	10½	85	6¾	12	9	12	5½	93	115	210	9	19	19	89	96	65	195	220
1:30	2000	145	160	2250	2800	5	700	90	120	195	194	28	205	47	9	125	195	...	550	570	540	10	10½	86	6¾	12	9	12	6	90	115	205	9	19	19	88	96	64	198	225
2:00	2000	150	145	2150	2900	4½	700	92	120	195	195	28¼	206	47	9	125	195	...	540	585	550	10¼	10¼	88	6¾	12	9	12	6	89	115	205	9	17	19	87	96	62	200	235
2:30	1950	150	142	2050	3000	2½	700	92	125	192	200	28	210	47	9	125	199	...	550	530	550	10¼	10¼	87	6¾	12	9	12	5½	95	115	217	10	20	19	89	96	68	183	230
3:00	1900	140	140	2000	2900	3	700	92	125	195	200	28	210	47	9	125	198	...	540	530	550	10½	10¼	86	6¾	12	9	12	5½	95	115	220	14½	21	19	89	96	68	185	222
3:30	1900	145	140	2100	3000	3½	700	95	125	185	200	27¾	208	47	9	125	196	...	530	530	540	10¼	10	86	6	12	9	12	6	98	115	230	8½	21	19	89	96	[69	...	...

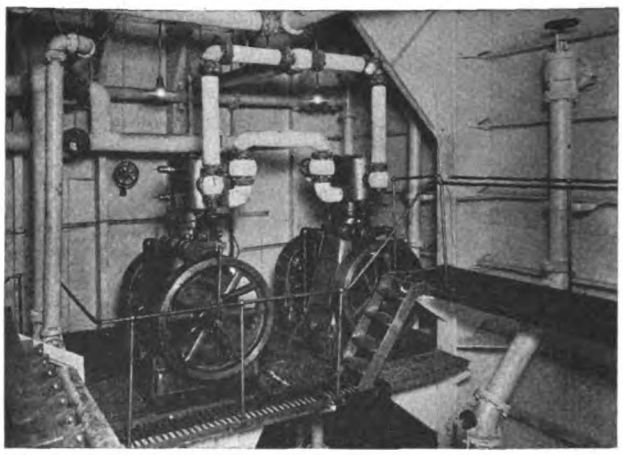

Fig. 8.—Two 35-Kilowatt, 125-Volt Direct Current Exciters

and an auxiliary handle for operating a fused disconnecting switch in the control circuit, leading from the 125 volt power supply to the master controller. There are also levers connecting either exciter into circuits, two exciter resistors, one for each exciter, and levers for connecting the blower and generator field to the exciter bus.

If for any reason it becomes necessary or desirable to operate the control group manually, this may be accomplished by means of three levers mounted at the left side of the control panel. These are, from left to right, the resistor lever, the field lever and the reverse lever, which actuate the contactors directly by means of cams.

An outline of the sequence of operations required for starting and reversing the *Eclipse* or maneuvering is in general as follows:

First, assuming that all preliminary operations had been performed, the turbine is brought up to 25 percent of its full speed by means of the governor control, giving a frequency and voltage of approximately 25 percent of the alternator's normal characteristics.

Second, by means of the electric automatic control

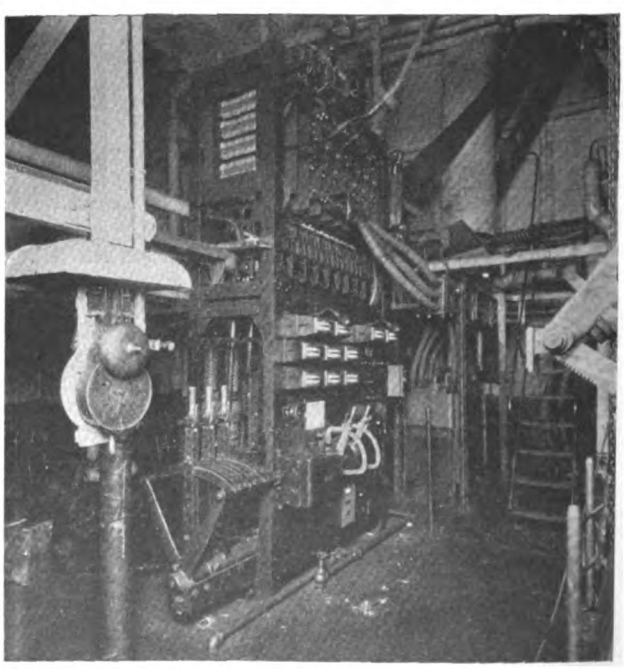

Fig. 9.—General View of Control Board, Showing High-Tension Contactors, Meters, Control Levers and Water Rheostat Which is Connected Into the Secondary Circuit of the Phase-Wound Rotor During Starting and Reversing Operations

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lever which is both mechanically and electrically interlocked, as noted above, the main magnetic contactors are closed on the motor circuit with all resistance inserted in the secondary windings.

Third, the automatic electric lever is then advanced, which operation automatically closes the magnetic contactors, giving field excitation to the alternator, causing revolving magnetic fields in the motor's stator winding and consequently the induced current in the secondary winding, which produces a revolving torque.

Fourth, as the motor produces synchronous speed for a frequency of 12½ cycles per second, namely, 25 revolutions per minute on the motor, the secondary resistance is automatically cut out and the phase wound rotor short circuited upon itself by a further movement of the automatic control lever.

Fifth, the motor is then directly and electrically tied in with the alternator, operating as a squirrel cage machine, which means that greater speeds are then obtainable by increasing both the frequency and voltage of the line current, which is done by increasing the excitation to the fields of the generator and opening up the steam throttle of the turbine, whereby its rated speed for a given load may be developed.

CONTROL OPERATIONS IN REVERSING

Exceptionally quick and powerful reversal is effected by throwing the steam lever which controls the turbine governor to one-quarter speed and then bringing the electric control lever to neutral position. The electric lever is then placed in the reversed position, which automatically inserts a secondary resistance and closes the field excitation as it was performed during the starting operation. After the motor approaches synchronous speed for a frequency of 12½ cycles per second in the reversed direction, the electric lever is further advanced on the reverse control, cutting out the secondary resistance and following the same sequence of operations as was performed in the forward movements.

When the ship is under full speed ahead and reversal is desired, due consideration must, however, be given the excitation meter, which is located on the control board, in order that momentarily heavy over-excitation may be supplied to the generator to counterbalance the powerful braking torque that is necessary before and after reversal of the propeller becomes effective.

The excitation instrument that has been supplied with this equipment supersedes all meters that have yet been devised or installed on any electric ship. It indicates to the operating engineer at a glance the amount of field excitation necessary for both heavy and smooth sea sailing, as well as excitation necessary during the periods of reversals.

ACCEPTANCE TRIALS OF THE ECLIPSE

The original steam driven auxiliaries in the *Eclipse* have been utilized in the new installation, the electrical equipment having been put into the vessel with the least amount of alteration of the installation as it existed. Before the vessel was taken over by the Shipping Board to be used in the service of the American Line of the International Mercantile Marine, she was given a six-hour sea trial, the results of which will be found in the accompanying tables. The trials were satisfactory so far as the performance of the vessel was concerned, although no conclusive estimates could be made of her possibilities in actual service, since the trial was run with the ship in ballast, the propeller being about 18 inches out of water.

TABLE II.—RESULTS

Kilowatt hour meter reading at start of trial	0017.8
Kilowatt hour meter reading at finish of trial	0029
Constant kilowatt hour meter	1000
Total kilowatt hours used on trial trip	11,200
Total oil used on trial trip, less 5 percent slip for meter inaccuracy, gallons	3,220

Temperature of motor stator at finish of trial—forward end, 52 degrees C.; astern side, 59 degrees C.
Engine room temperature varied from 30 to 33 degrees C.
Temperature of rotor at finish of trial 46 degrees C. on astern side; 48 degrees on forward side.

Do Not Kill the Goose That Lays the Golden Egg

BY "OLD SCOTCH"

I am addressing these plain and frank remarks primarily to American marine engineers, and secondarily to all Americans interested in the success of our merchant marine. The writer is a marine engineer himself and has not a dollar invested in shipping; consequently, he is making this appeal from a friendly interest in marine engineers and an intensely patriotic desire to see our merchant marine succeed.

FOR the past three or four years golden eggs have been dropping in your baskets, my marine engineer brothers, in a number which you hitherto have never dreamed to be possible, as your wages have grown to such an extent that you are well fortified in combating all your legitimate expenses. Your pay is much higher than the wages paid for like services on the ships of any other nationality. That is as it should be, as you are Americans and entitled to the best. But there are obligations on your part which must be fulfilled faithfully and energetically, if these "golden egg" days are to continue.

First you must distinctly understand that the world's shipping is an "open shop" of the very openest type. All nations are free to compete for the business, and American ships are not favored one bit in the keen competition. The American shipowner does not receive a penny more freight money for the goods he transports than does any other shipowner in the wide world. We all know that to pay out money we must first receive it. Now with our income limited in shipping, we must carefully guard our outgo, or to reverse it, we will *"go out"* sure enough, and good-bye golden eggs in the shape of high wages.

The engineers on any ship are the principal class of employes who can make ship operating a success or a failure. On your efficiency the whole enterprise must depend to a very great extent. Deck officers may dress in cleaner

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clothes, and if they are successful in keeping the ship out of collisions or from striking the beach, it makes but little difference how efficient they are otherwise so far as the financial success of the ship is concerned.

Fuel and repairs are two of the important items of expense in operating the ship, and for these you engineers are directly responsible. If you are not skilled in your business and are careless, you can easily waste not only all the profits of a voyage but have the ships run at a loss besides. You can give one guess as to how long an owner will continue to run his ship at a loss, and when ships don't run, where is your job going to be? I regret to tell you that some of you are leading up to just such an ending, and unless you reform at once many of you will be out of a job before many weeks have passed. Some may say that this is a lot of "bunk," but let me quote you some recent figures from an absolutely reliable source. They represent monthly averages of three vessels operated under the British flag, and three operated under the American flag, all under the same ownership and engaged on the same routes. They are all oil carriers and average 11,500 tons deadweight each.

Relative Costs of Operating American and British Ships

For provisions the British monthly cost for each ship was $1,495, as compared with an American cost of $2,300, showing that you are fed better on the Yankee ships.

For deck stores the British paid $1,035 per month on each ship, and the American only $805 per month, showing that our deck officers must have been more economical than the British in this small item of costs.

For engine room stores the British monthly charge was $460 each, while American engineers used $805 worth.

The wages for officers and men cost each of the British ships $3,680 per month, while the American cost was $4,370, showing plainly who gets the better pay.

Now comes the item of repairs, and we find that while each British ship paid only $1,265 per month, the cost per month on each American ship was $7,245. Just think of that—fifty percent more than the entire cost of wages of officers and crew every month! True, this was the cost of the repairs to the entire ship, but the bulk of them was in connection with the steam machinery. Neglecting depreciation, interest charge, fuel, insurance and port charges, which should be about the same on ships of any nationality engaged in the same trade routes, the increase in cost of operation for each American ship over that of the British ship was $7,590 every month.

Where is that to come from? They each received the same amount in freight money. Do you think that because of the past great demand for shipping this condition of affairs can go on indefinitely? No, my friends, American shipowners are not philanthropists and they will not continue to run their ships at a great loss just to give you engineers and deck officers good jobs at high rates of pay. Disabuse your minds of that idea very quickly.

Just keep in mind that the ships I have quoted above are privately owned where such conditions existed. The Lord only knows what the cost of repairs and stores have been on the Shipping Board ships during the same period.

Overtime Charges Ruinous

Another iniquitous thing that is being put across is this pay for overtime you are demanding and getting at this time. When I first went to sea and when you older men went to sea, an engineer who asked for overtime pay in case he worked over eight hours per day would have been thrown on the beach in about two seconds. Many of you are putting off jobs that you should do during your eight-hour shift, so that you can soak the owners for overtime, when you do something which you ought to have done on your watch. Some of you are getting $50 to $100 a month for this overtime, in addition to the already big wages you receive. Now don't think that you can get away with this kind of action very much longer. Already vessels are being withdrawn from trade owing to the rapidly diminishing freight rates. Many more will follow, if you continue to neglect your jobs and allow these enormous charges for repairs and overtime to roll up as you are doing now.

I am told that many of you want to do these small repairs but that your men are no good and that you have some Bolshevists among them who keep the men disgruntled. That is, I'm afraid, too true, but the good, old-time engineers of not many years ago had a way of handling such scalawags, which you might try a hand at now if you are in earnest. Take them one at a time in a coal bunker and "argue" with them in the good old-fashioned way. You know the way I mean. That ought to cure Bolshevistic tendencies.

Many of you men now holding licenses are new at the game and consequently have not been through the mill of hard times. Just listen then to the older men in your organization. They know that what I have told you is absolutely true. All this war stuff and scarcity of ships is over right now, and if you want to continue to hold your good jobs you had better begin to mend your ways and cut out all this foolishness. Striking isn't going to do any good, as it might be a good thing to tie up a good many of the ships that are beginning to be operated at a loss. We must, from national pride and for national interests, have a merchant marine, but if you men are not willing to do your part towards it, then the whole thing will go to smash and you will soon lose the best jobs you ever had in your lives or ever dreamed of having.

What would happen on English, Norwegian or Japanese ships if such repair bills were run up as have been run up on American ships? They don't get as good wages as you do, and they don't have the nerve to demand overtime, but they are running their ships more efficiently than we are.

Aren't you as good engineers as these fellows? Have you no pride in your business or in your country? I have been boosting American marine engineers all my life, as I believe in them. I know that you are as capable as any who sail the seas, and I want to see our merchant ships compete with the world. You can keep them going if you want to do it. I appeal to your pride as Americans, and, above all, I appeal to your self-interests, if you want to hold so many good jobs as you are now holding. I am glad to say that these criticisms apply to a comparatively small number, but few as they are they have caused a great deal of unfavorable comment which you will readily understand reflects on the whole engineering brotherhood. You should be the first to rid yourselves of these undesirables, and, knowing you as I do, I have every confidence in you to do that very thing.

It's a good fat goose, I'll admit, but her golden eggs have an end to them, if you don't watch out.

The Bureau of Navigation, Department of Commerce, Washington, D. C., reports 128 steam motor and sailing vessels of 259,611 gross tons built in the United States, and officially numbered during the month of September. This total includes 28 vessels of 159,114 gross tons built for the United States Shipping Board. Tanker tonnage for the month amounted to 63,571 gross tons, of which four vessels were for the Shipping Board and five for private companies. In addition to this construction, seven vessels of 2,351 gross tons were built for foreign account.

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What Will Congress Do?

BY WALDON FAWCETT

What will Congress do? This is a question that is always in order with American business men at the opening of a session of the national legislature. For shipping and shipbuilding interests it has, however, particular poignancy at this juncture. So numerous are the pending problems that have contact directly or indirectly with the merchant marine, and such, in many instances, is the pressure for solution, that it is inconceivable that the law-making body can function without taking action of some significance to the industry.

THE rather unusual situation that exists justifies in shipping and shipbuilding circles an expectation of developments at a "short" session of Congress. It is axiomatic at Washington that Congress is loath to initiate new policies or launch projects that mortgage the future at a session that ends by limitation in three months. Perhaps senators and representatives hesitate to take up issues when they are forewarned that debate will be cut short, but whatever the animus it is proverbial at the capital that the so-called short sessions of Congress are given over largely to the passage of appropriation bills and other measures requisite to the continued operation of the government.

In the present instance there is added an extra influence for inaction. The impending session marks the final fling of the Sixty-sixth Congress. It follows hard upon the heels of a national election which, aside from embodied popular expression upon Congressional policy, has served notice upon a certain proportion of the lawmakers that their services will be no longer required. To this extent the final session of a dying Congress is inevitably an anti-climax. And when, as in the present instance, we have the dominant force in Congress at odds, politically, with the executive administration, there is every encouragement to mark time pending the new day.

Congressional Reaction to Merchant Marine Problems

Despite all these deterrents and in disregard of the further fact that it is confidently predicted that the new Congress will be called in extra session early in the spring, there is virtual certainty that the interim between December 1 and March 4 will witness Congressional reaction to certain merchant marine problems. The policies and performances of the United States Shipping Board, the enforcement of the new Merchant Marine Act, the adjustment of the claims of wooden shipbuilders, etc., etc., present angles that seem certain to enlist controversial attention whatever interpretation be placed upon the November verdict at the polls.

Undoubtedly Congress, and especially that proportion of its membership that has won re-election, will return to the legislative treadmill with minds more or less inflamed on merchant marine issues. To an extent unparalleled in the recent history of the country have these been made the subject of campaign debate. Our readers are familiar, for example, with the discussion that has waged over such questions as the legality of action taken by a minority of the prescribed membership of the Shipping Board; the sanction of an alliance between a subsidiary of the Shipping Board and the Hamburg-American interests; and the refusal of the President to carry out the provisions of that section of the Merchant Marine Act dealing with the abrogation of treaties which are counter to the new Federal policy of discriminatory tonnage dues and duties on imports. Without attempting to forecast precisely regarding the manifestation that will appear, it may be anticipated that the sequel of the campaign analysis of merchant marine problems will have impress upon both the Sixty-sixth and Sixty-seventh Congresses.

Any experienced watcher of the play of partisan politics might surmise that a Republican Congress would lose no time in reacting to the refusal of a Democratic President to carry out an important provision of law enacted by the aforesaid Congress. It is uncertain, however, whether Congress will be precipitate in grappling with the foreign entanglements of the Merchant Marine Act. There will be talk in the halls of Congress, just as there has been talk "on the stump," extending to such lengths as suggestion of the impeachment of the President, but when it comes to action in insistence upon the will of Congress there is encountered a considerable sentiment in the expiring legislature in favor of passing the entire responsibility to the new Congress. By the by, it is coming to be realized in official circles generally that pronouncements from the Supreme Court of the United States may be required on questions of constitutionality involving sections of the new law other than the one dealing with foreign treaties.

Enforcement of Merchant Marine Act

Postponement of action with respect to the full enforcement of the Merchant Marine Act has, in the eyes of some interested persons, the merit that it would allow time for a crystallization of whatever resentment and retaliation may have been engendered in foreign quarters. In other words, there is a feeling on the part of some that, if it should prove necessary to put new teeth in the Merchant Marine Act, it might be just as well to hold off until it becomes apparent what form alien antagonism or competition is to take. Already, for instance, there is conjecture in responsible quarters whether it may not be necessary, in the interest of a merchant marine that shall be bona-fide American, to stiffen the requirements as to American control in corporations that may acquire contracts, shipping or shipbuilding property from the government.

In passing it may be remarked that, if any participant in the industry is prone to be bothered by rumor, he has had ample reason for disquietude in the gossip that has had circulation in and out of print ever since foreign interests began to take umbrage at the effort to establish a merchant marine worthy of the United States. First came the stories of a possible diversion of ships, which seemingly worried certain port authorities on the Pacific Coast, and gradually the propaganda progressed until it brought forth the alarm that foreign interests intended to purchase and dismantle the Hog Island shipbuilding plant as a means of curtailing American resources for the upbuilding of a merchant marine. Action of the Shipping Board in declining to comment on some of the rumors set afloat has, in some instances, but added to the unrest that has been occasioned.

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INVESTIGATION OF SHIPPING BOARD OPERATIONS

While it is doubtful to what extent, if any, the Congress that is about to close up its business will indulge in what might be termed new legislation relative to the merchant marine, it is reasonably certain that we shall have a continuation of the investigation of Shipping Board operations. So exhaustive were the hearings, touching incidentally upon this subject, before the commerce committee of the Senate that there appears little disposition to reopen the inquisition in the upper house of Congress. The situation is different, however, in the House of Representatives. Here there remains, primed for further action, a select committee on United States Shipping Board operations composed of Congressman Joseph Walsh, of Massachusetts (chairman); Patrick H. Kelley, of Michigan; Lindley H. Hadley, of Washington; Israel M. Foster, of Ohio; Henry J. Steele, of Pennsylvania, and Tom Connally, of Texas.

"CLAIMS" OF SHIPBUILDERS AWAITING SETTLEMENT

One circumstance that renders it certain that Shipping Board practices and policies will continue to claim considerable attention, not only from the Sixty-sixth Congress in its final days but likewise from the Sixty-seventh Congress, is the number and aggregate magnitude of the "claims" of shipbuilders awaiting settlement. The claims of the wooden shipbuilders for reimbursement for investment, etc., have been mentioned as one of the most formidable war-incurred responsibilities of the government, but there are ramifications of this claim's question that are far-reaching. For example, there are shipyards that have changed ownership or gone into the hands of receivers or otherwise come in for change of status that begets complications when it comes to the adjustment of claims.

The matter of the "extras" allowed or expected to be allowed on the ship construction contracts entered into by the United States Shipping Board Emergency Fleet Corporation is in itself a potential source of disagreement and misunderstanding, the heritage of which is likely to long survive. That this is so is due in no small measure to the fact that a number of shipbuilders, while engaged in government work, kept no detailed record of "extras" and of the time, labor and material going into these extras. The shipbuilders pursued this course under the impression that in the final adjustment they would be allowed lump sums for extras. Accordingly, when in the rush and hurry of wartime shipbuilding inspectors gave oral instructions for this or that change, these instructions were followed in confidence that all the slack would eventually be taken up in a cumulative settlement for extras. This explains the shock and disappointment suffered by some shipbuilders when question was raised as to the propriety of payment of lump sums of as much as $50,000 per vessel for lumped "extras."

MISCELLANEOUS MEASURES

Aside from the pending legislation to adjust the claims of shipbuilders there are a number of miscellaneous mercantile marine matters before the Sixty-sixth Congress that stand a reasonable chance of being brought to vote in consequence of a desire on the part of their authors or sponsors to obtain a verdict from the existing legislature. This is the case with bills upon which hearings in committee have been conducted. If the current Congress is allowed to adjourn *sine die* without action upon a proposition of this kind, it means that valuable time must be lost, since the measure when reintroduced in the new Congress is likely to be recommitted to committee and all the ground that has been covered by the hearings must be again traversed in new hearings. The urge for conclusive action is even more acute in the case of bills that have been approved in one house of Congress but lack the endorsement of the other house because not yet reached on its calendar.

As has been said, there are a number of bills whose fate thus hangs upon the willingness of this Congress to act in the three months of its tenure that remain. In this category are the measures to provide for the classification of United States vessels; to permit a limited number of passengers on cargo ships; to establish load lines for vessels, etc. A line of contemplated legislation upon which expectations remain unfulfilled is that which seeks to encourage American citizens to enter the merchant marine by holding out concessions such as a reduction in the length of sea service required on training ships. There are also optimists who hope that this Congress, ere it departs, will legislate further in encouragement of the provision of all-American insurance facilities for the merchant marine.

Almost as interesting to many shipping and shipbuilding interests as the prospect for new legislation affecting the technical side of the industry is the outlook for legislation designed to relax the present exactions of Federal taxation. While the Merchant Marine Act affords a loophole for firms that are in a position to contract for the construction forthwith of new tonnage, there are countless firms in the maritime field that, shut off from even this form of consolation, await anxiously a revision of the income and excess profits taxes.

FEDERAL TAXATION

While popular sentiment has crystallized markedly in favor of an overhauling of the Federal taxation system, it cannot be said in all candor that there is any reasonable assurance that Congress will attempt action at the short session. Rather does there appear to be a disposition in Congressional circles to postpone the revision of the system of internal revenue until it can be considered in conjunction with the problems of a general revision of the tariff which it is confidently predicted in many quarters will be attempted by the new Congress. With the new vision of American participation in the world's carrying trade, United States maritime interests will be impelled to watch closely the evolution of a new tariff policy. That Great Lakes commerce no less than overseas trade may be affected by the tariff changes that are in prospect in this and other countries is hinted by the fact that a spirited contest is now on in Canada to determine whether the Dominion shall adopt a policy even more pronouncedly protectionist than it has followed in the past, for all its anti-dumping act and its disdain of the United States offer of reciprocity.

With the marked trend in the maritime field from coal burning to oil burning steamers there will be supplied definite incentive for shipping men to watch closely the progress of national legislation that deals with petroleum and kindred natural resources. In this same connection the statement may be ventured that by no means all shipping men have as yet sensed the significance of the Oil and Gas Leasing Act which Congress approved in the early part of 1920. Similarly, not all the shipping men who are dependent upon liquid fuel appreciate that legislation governing international relations, say relations with Mexico, is likely henceforth to have a meaning all its own for builders and operators of oil burners.

PATENT LEGISLATION

Half way through Congress, and consequently an object of especial conjecture, is a measure whose significance to the shipbuilding and ship outfitting industries has not been generally appreciated. The measure is one that would empower the Federal Trade Commission to administer the inventions made by experts and employees in the service

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of the United States Government. It is designed to render available for the fullest commercial use many valuable discoveries and inventions which under present conditions are not exploited.

As readers of MARINE ENGINEERING are well aware, specialists in the United States Navy and in engineering and technical divisions of the public service perfect, every now and then, inventions that would prove quite as serviceable in the merchant marine as on the governmental craft for whose purposes these innovations are, we will suppose, primarily designed. In the case of none of these inventions has the government, in time of peace, maintained a monopoly. Quite the contrary. Patents taken out upon inventions worked out on government time and with government facilities have usually been dedicated to the public.

Evidently, however, the very liberality of this intent to share with private industry the fruits of Governmental research has defeated the purpose that it was sought to accomplish. It has been found that, as a rule, private manufacturers have been loath to place on the market the inventions that were, in accordance with Federal policy, open to all comers. The explanation given universally in the case of inventions that would require any considerable plant equipment was that no manufacturer could afford to risk the investment necessary to bring about production on a commercial scale when his enterprise might be penalized by any or all competitors who saw fit to enter the field once the pioneer had created a market.

It is this undue freedom of competition that the measure now before Congress is designed to correct. By its provisions the Federal Trade Commission would be empowered to conduct a clearing house for all governmental inventions that might be found worthy contributions to the world's mechanical and scientific equipment. Each invention having merit will be patented, and instead of a free-for-all policy the Trade Commission will restrict manufacture under the patent to one or more duly approved licensees. The intent is to authorize manufacture in each case by a sufficient number of manufacturers to insure adequate production and a proper degree of competition, but to avoid overproduction by promiscuous manufacture, and yet, more important, to give to each licensee reasonable assurance of a sufficient volume of business to warrant the needed investment for factory, patterns, etc. It is contemplated that modest royalties be charged on all inventions. The revenue thus provided would cover the cost of administration of the license system and also afford to each inventor in the government service a small bonus that would be an incentive to creative effort.

Likewise, half way through Congress is another patent bill of more or less moment to shipbuilding, equipment and supply interests. This measure undertakes to remedy conditions at our overworked and undermanned Patent Office by an increase of the examining force and a horizontal increase in salaries—the latter designed to hold in the service the trained experts so essential to efficient administration of the patent system. Interests in the maritime field that have been inconvenienced latterly by the well-nigh intolerable delays in passing upon new inventions, original designs, etc., would welcome the betterment of conditions that is half promised.

Comparison of Cargo Transportation by Land and Water Routes*

BY WILLIAM T. DONNELLY†

THE building of many canals all over the world in years gone by bears testimony to the fact that transportation of cargoes on the water costs much less than by overland routes. The present development of inland waterways in this country and especially the barge canal in New York State is based on the same sound principle. What then is the explanation of the public attitude towards these enterprises other than the effect of the opposition of the railroads to their exploitation?

A careful survey of the whole subject indicates very clearly that the canals and inland waterways, as used, lack dispatch. They are too slow. The public mind associates the canal barge with a mule's pace—his walking gait—and shipments by this method only appeal to the public as suitable for cargoes of non-perishable, almost non-essential, freight of such a nature as to be unaffected by the rapid fluctuations of market conditions. The shipper takes the same attitude and forwards his goods by rail. Fast freight and express are the terms that appeal to him, so that he may deliver his goods to a given destination quickly and turn over his investment.

However, fast freight is no longer fast, and even the express is slow. Moreover, both methods of shipment are

* Paper read before the Atlantic Deeper Waterways Association Convention, Atlantic City, October 7.

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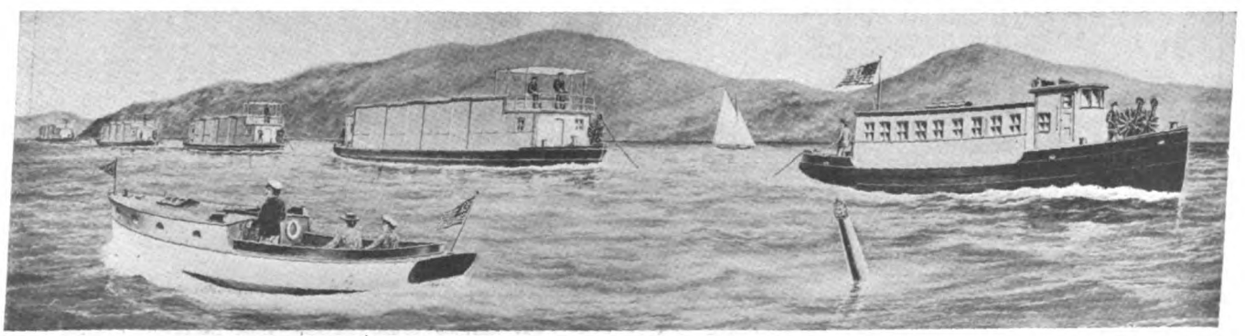

Fig. 1.—Proposed Fleet of Electrically-Propelled Power Boat Supplying Electric Current for Propulsion of Four Barges for Inland Waterway Transportation

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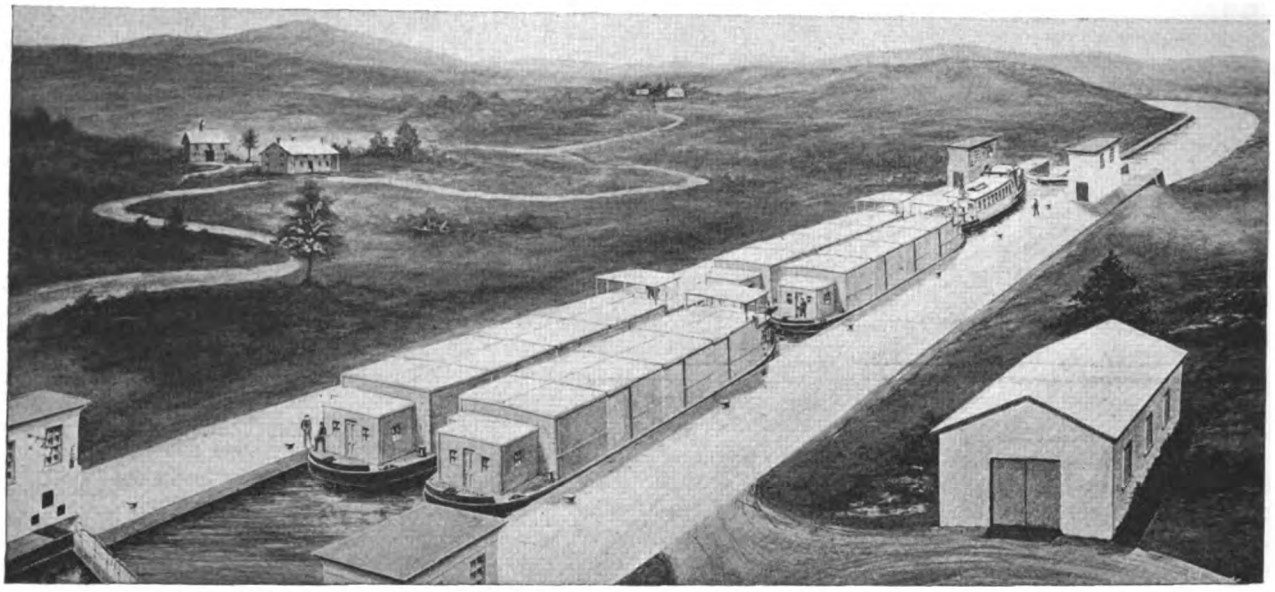

Fig. 2.—Electrically-Propelled Barge Fleet in Canal Lock

handicapped by increasing numbers of embargoes made necessary by the congestion of both tracks and terminals as well as a shortage of cars.

PROPOSED FREIGHT TRANSPORTATION SYSTEM

In developing a new plan for the prompt dispatch of cargoes by inland water routes, a system has been proposed which no longer depends on the tow line, but uses instead fleets of separately propelled vessels traveling together in convoy with a central electric generating station afloat connected to the fleet by cable and with all propellers driven by electric motors. All the component parts of this system have been tried out and proved practical and operative at the same high economy as central stations ashore or the multiple unit trains on the electrified railroads.

In practically all water transportation of package freight at the present time the material is delivered by a common carrier to the pier, from which it is rehandled to the barge or vessel. This carrier again delivers the packages upon another pier, piling them in the most convenient way for delivery, which is often the most inconvenient for rehandling. From this pier they are again rehandled approximately one-half to storage and one-half to immediate delivery. The storage is at warehouses, for the most part built in the congested part of a city, near railroad and marine terminals, where land is of high value.

In contra-distinction to this, the proposed method and system of transportation would function as follows:

The transportation company will receive the goods from the owner at his factory, and load them upon automobile trucks propelled by storage batteries. In this first loading, the package goods will be placed upon a movable body or truck platform. The truck will then proceed to the water terminal, it being understood that goods will not be called for at the manufacturers unless the barge for transporting them is waiting at a terminal within a distance not to exceed ten miles.

Upon the arrival of the automobile truck at the terminal, the entire load will be removed as a unit by an adequate lifting crane and placed as a unit upon the deck of the electrically propelled barge. The mechanical capacity of the terminal will be adequate to load 800 tons in four hours.

The water transportation unit will comprise four barges,

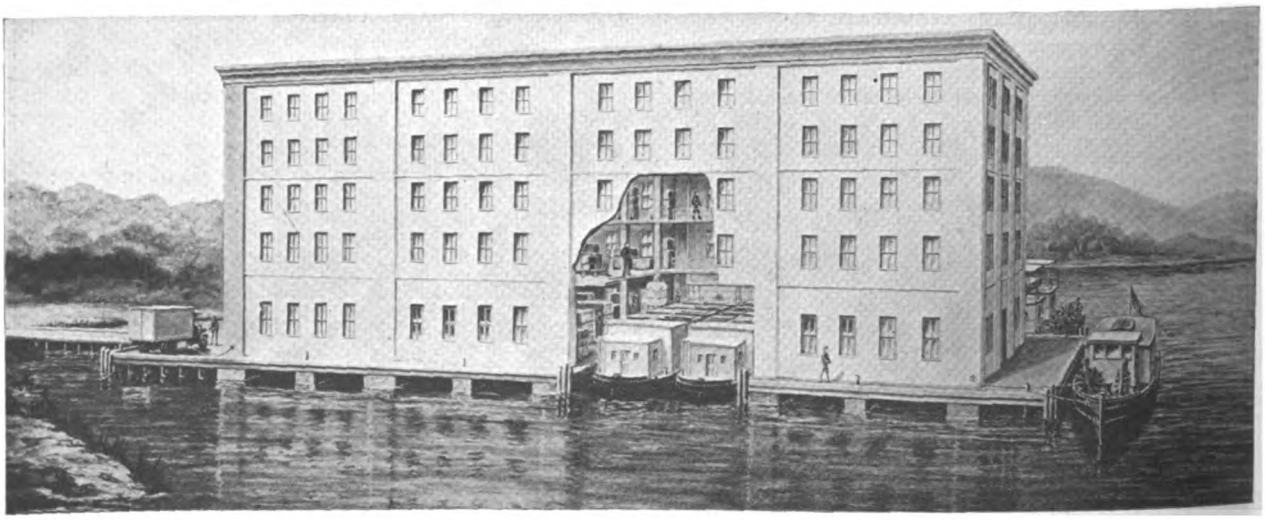

Fig. 3.—Fleet of Barges Delivering Cargo to Warehouse built on Piles Over Shallow Water. Power Boat Supplying Current for Operation of Freight-Handling Machinery in Warehouse

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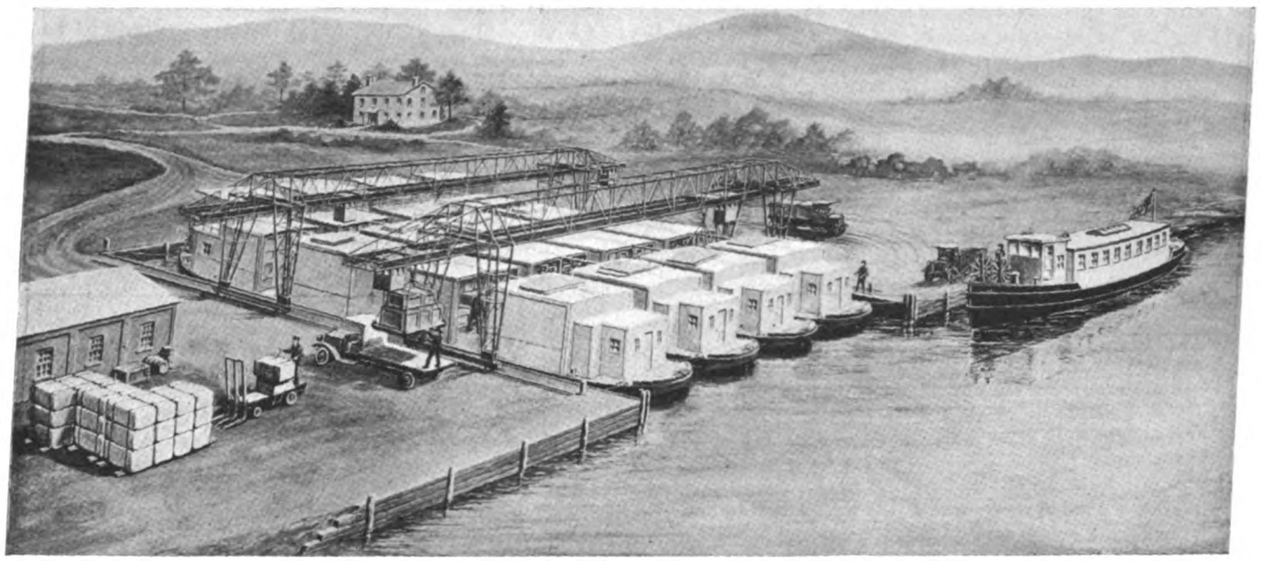

Fig. 4.—Proposed Barge Terminal, Showing Use of Gantry Cranes for Transferring Freight from Barges to Automobile Trucks

each having a capacity of 200 tons and provided with an electric motor and a propeller, capable of driving it at a speed of nine miles an hour in all open harbor and river waters. The power for this propulsion will be supplied by an electrically propelled vessel, carrying electric generating machinery of ample power.

Upon the arrival of this fleet at its destination, either of the two deliveries may be made. If the entire cargo is for immediate delivery, the barges will proceed to the terminal, precisely as to a loading station, there the package goods in units of automobile truck loads will be immediately transferred to electrically propelled trucks for delivery.

In the case of barges carrying goods which are not for immediate delivery, the barges will not go to the landing terminal but into a warehouse built over shallow water on submerged land. This is land of the very lowest value, upon which warehouses could be erected, fire-proof if so desired, for the least unit cost. From the deck of these barges the goods for warehousing will be lifted and placed within the warehouse at one movement, it being understood that the warehouse will absorb this cost of unloading minus the cost of hooking on which will be done by the crew of the barge.

It is to be understood that delivery will be made from this warehouse by automobile trucks propelled by electric storage batteries, the transfer of the goods to the trucks to be made in units of truck loads entirely by mechanical power.

This method of rapid and economic package freight transportation should be organized and applied first to and between the large cities on our eastern coast and to such others in the interior as are readily accessible through our leading rivers and canal systems.

Such a system is specially adaptable to a special class of large manufacturers who require the delivery of several hundred tons a week, and to classes of goods that it is entirely practical to handle in units on automobile trucks, carrying from three to five tons.

For the purpose of arriving at the comparative cost of

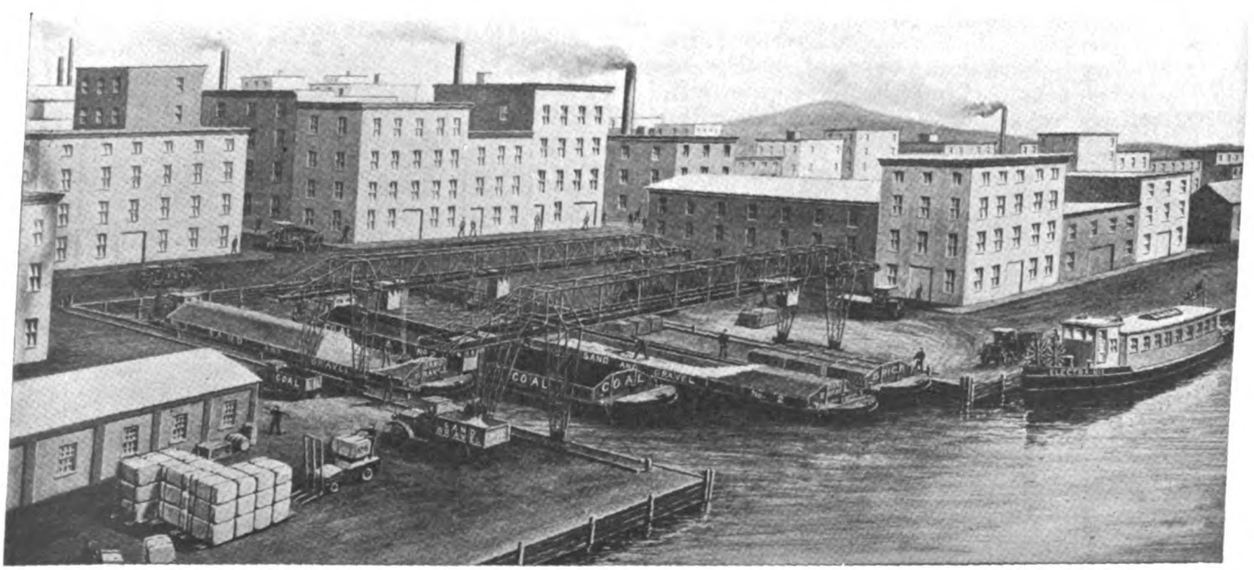

Fig. 5.—Proposed Barge Terminal for Handling Bulk Freight. Electric Current for Operating Terminal Cranes Supplied by Power Boat Moored Alongside While Barges Are Loaded and Unloaded

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this method of handling cargoes, a study has been made based on the regular dispatch of 800 tons of cargo by means of four 200-ton barges and one power boat to operate between Schenectady and New York city over the Hudson river and the barge canal. This report shows the result of the investigation.

Financial Analysis of Electrically Propelled Barge Operation

Each of the four 200-ton deadweight cargo barges is 105 feet long overall, 21 feet 6 inches beam and 10 feet deep. They are built of wood, full housed and accessible both from side and overhead hatches. They are made unsinkable on the same principle as the author's yachts, *Dawn* and *New Era* (described in MARINE ENGINEERING, April, 1920), whose non-sinkability has been demonstrated. This feature avoids the large expense of marine insurance on both cargo and floating equipment, substituting therefor fire insurance, which saves at least 80 percent of this feature of operating expense.

The draft loaded is 7 feet 6 inches, while the draft loaded with the vessel water logged is 8 feet. When water logged the deck is still above the waterline, and as the motor is located in a watertight well, the barge may proceed without interruption. No salvage expense is possible and when convenient, after collision or other mishap, the barge is repaired from funds provided for maintenance, as set forth in the statement following, showing the cost of operation. Each barge is driven by a 125 horsepower electric motor, coupled to a 4½-foot propeller, and receives its supply of electricity from the power boat by a flexible cable. Comfortable living quarters are provided.

The Power Boat

The power boat is 70 feet long overall, 17 feet beam and 6 feet draft. It is equipped with four 186 brake horsepower gasoline engines, direct connected to four 120 kilowatt dynamos, which supply the electricity needed by the fleet for all purposes. The engines are not reversible, run at constant speed and operate the same as any isolated plant ashore. The control of all the propeller motors is placed in the pilot house and handled by the navigator. The power boat is equipped with a 90-horsepower propeller motor and is also made non-sinkable.

Analysis of Operating Cost

It is quite certain that the fleet of full housed barges carrying deck loads of package freight referred to in this report can be fully occupied during the time that the canal is closed by applying them to harbor lighterage, or or by operating them for transportation in southern waters; therefore no idle time is provided for in this analysis.

The following table shows the several items of expense and following the table is a résumé of how the various items are obtained.

ANALYSIS OF COST OF MOVING 800 TONS IN A FLEET OF FOUR BARGES AND ONE POWER BOAT BETWEEN SCHENECTADY AND NEW YORK AT 9 MILES PER HOUR

Total distance, 178 miles; 154 miles at 9 miles per hour; 24 miles at 4 miles per hour. Actual running time, 23 hours. Time allowed for one trip, 3 days.

	Items	Cost per Ton
1.	Cost of fuel (gasoline) per ton of cargo	$.5800
2.	Labor (crew): 7 men on power boat, 3 men on each barge; total, 19 men	.3410
3.	Subsistence	.0710
4.	Loading and unloading, cost of labor outside of boat crews	.2400
5.	Interest on investment, 6 percent per annum	.0888
6.	Depreciation of floating equipment, 5 percent per annum	.0740
7.	Repairs and maintenance, 4 percent (United States Shipping Board)	.0592
8.	Cost of fire insurance on floating equipment (1 percent)	.0148
9.	Cost of fire insurance, mixed cargo, electric machinery, at 1 percent; valuation at .20 per pound, $400 ton	.0320
	Total	$1.5008

Cost to operating company, New York to Schenectady, $1.50 per ton.

Gasoline is used for this installation partly because it can be obtained practically anywhere at any time and because the additional cost of gasoline compared with fuel oil is offset very largely by the higher cost of Diesel motors and the consequent increased interest on the investment. The labor item for Diesel engines is also higher in proportion to the higher skill necessary for their operation.

Cost of Fuel

The distance one way between Schenectady and New York City is 178 miles, of which 154 miles will be traveled at 9 miles per hour on the river using 710 engine brake horsepower. The balance of 24 miles on the canal will be run at 4 miles per hour using 117 engine brake horsepower. The actual running time will be 23 hours and the consumption of gasoline 1,366 gallons, which at 34 cents per gallon equals $464 for the cargo of 800 tons, which is at the rate of $.58 per ton for fuel.

Analysis of Labor Required

Provision is made for a total crew of 19 men (not counting families who may live aboard the barges), seven men on the power boat and three men on each barge.

The distribution of labor is provided for as follows:

POWER BOAT

One captain, at $8 per day	$ 8
Two other men who can steer the boat, at $7 per day	14
Three men, at $5 (including a cook)	15
One electrician	7
Total per day	$44

BARGES

A captain is provided for each barge, who finds at least two helpers and he is paid $350 per month, making a total of $1,400 per month for the four barges, or at the rate of $47 per day.

The basis of a trip is one day for loading, one day for transit and one day for unloading. The total labor expense for the three days as outlined above will be $273, or at the rate of $.341 per ton of cargo.

Subsistence of the crew provided for in a recent report by the United States Shipping Board allows $.86 per man per day. In the case of relatively small crews, $1 per man per day is provided. For 7 men on the power boat and 12 men on the barges, this item amounts to $19 per day, or $57 for the 3 days' trip, which is at the rate of $.071 per ton of cargo.

Loading and Unloading

It is part of the plan for the operation of the barges that the cargo shall be handled by a system of overhead cranes, which will reduce this item to not over $.10 per ton of cargo handled, but for the purpose of this analysis the common method of handling cargoes by means of hand trucks is used as a basis and at a cost of $.24 per ton handled.

Eight hundred tons off and on represents 1,600 tons handled. Assuming that half the labor will be supplied from the boat crews while in port, then half the labor cost may be added to the operating cost, or $.24 per ton of cargo for 800 tons.

Interest on Investment

It is estimated that the barges, which are of special and easy construction, can be built for $100 per ton deadweight carrying capacity, which makes a total of $80,000 for the barges. This, with $15,000 for the power boat hull and $49,000 for machinery, makes a total of $144,000 investment for floating equipment. Six percent on this amount is $8,640 per annum. Allowing 3 days for the trip, this item will be $71 for our 800-ton cargo, which is at the rate of $0.0888 per ton of cargo.

Five percent per annum is allowed for depreciation, which, based on an initial cost of $144,000, amounts to

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$7,200 per annum, or at the rate of $.074 per ton of cargo.

A recent United States Shipping Board report allows 4 percent of the contract price for repairs, and on this basis our charge will be $.0592 per ton of cargo.

FIRE INSURANCE ON FLOATING EQUIPMENT AND ON CARGO

One percent per annum is allowed on the full value of $144,000 for insuring the fleet, which on the basis of 3 days for one trip, as above, amounts to $.0148 per ton of cargo.

It is assumed that a large part of the merchandise carried between Schenectady and New York will be electrical machinery and electrical supplies, and that $.20 per pound will be a conservative valuation of this kind of cargo, or at the rate of $400 per ton. A blanket fire insurance policy on this basis at 1 percent will amount to $4 per ton per annum, and for one trip of 3 days this amounts to $.032 per ton of cargo.

As shown on the below table, the total of the nine items is $1.50 cost to the operating company per ton carried.

ANALYSIS OF DISPATCH OF SHIPMENTS OF ELECTRICAL MACHINERY, ETC., BETWEEN SCHENECTADY AND NEW YORK

ROUTING	CAR LOADS FREIGHT N. Y. C. & H. R. R. R.	LESS CAR LOADS FREIGHT N. Y. C. & H. R. R. R.	EXPRESS AMERICAN EXPRESS COMPANY	MOTOR TRUCK EXPRESS	ELECTRIC MOTOR BARGE
Time in transit.....	*One Week*	*Two Weeks*	Uncertain Under Normal Conditions Deliver Next Day after Shipment	$1.00 Per Mile 5 Tons 160 Miles $160.00	One Day No Uncertainty
Cost to shipper per ton old rates.....	$3.40 Practically Cost to Railroad	$7.90	$23.00		
New rates now in force.....	Flat 40% Increase		Flat 12½% Increase		
Cost to shipper per ton.....	$4.76	$11.06	$25.87	$32.00	$1.50 Cost to Operator

COMPARISON WITH OTHER METHODS OF HAULAGE

The preceding table is the result of careful inquiry into all overland routes between Schenectady and New York. The old car load freight rate between these points was $.17 per hundred pounds, which was at the rate of $3.40 per ton and is now increased 40 percent, making the cost $4.76 per ton. The less car load rate was $.39½ per hundred pounds, which was at the rate of $7.90 per ton and is now increased 40 percent, making it $11.06 per ton.

The express rate was $1.15 per hundred pounds, which is at the rate of $23 per ton, and is now increased 12½ percent, making the cost $25.87 per ton.

A large automobile truck company recently quoted $1 per mile for 5 tons carried. The distance by good roads is 160 miles. The total of $160 for 5 tons is at the rate of $32 per ton.

The agents in New York who quoted the rate estimated delivery of car load shipments in one week; less car load, two weeks, but would make no promises. Express shipments are now taking two or more days in transit, often more.

The only certain delivery in this schedule which can be depended on is by water transportation, which requires one day for transit. The dispatch is therefore equal to express under normal conditions or motor truck, which, at best, if shipped one day might arrive the next day. The cost to the operating company is less than half the lowest freight rate.

An explanation of this amazing fact is not hard to find. A comparison was made to determine the relative amount of power required to move cargoes on the railroad and by water route.

PERFORMANCE OF ELECTRIC LOCOMOTIVES

The electrification of our trunk line railroads for considerable distances and the use of electric locomotives for hauling freight has made it possible to obtain very accurate data on the power required to haul freight trains. In a paper read by W. S. Murray before the Franklin Institute, he related the performance of one electric locomotive of 1,400 horsepower hauling a 1,500-ton train at 35 miles per hour and two electric locomotives totaling 2,800 horsepower hauling a 3,000-ton train at the same speed. These speeds are necessary to work in between passenger trains when there is a clear track. The weight of a 50-ton freight car is 15 tons and the cargo 35 tons, so that the weight of cargo carried is as 50 is to 35. Therefore the weight of cargo carried by the 1,400-horsepower locomotive is in round numbers 1,000 tons, or 1.4 horsepower per ton carried.

An average of 560 horsepower is used by the 800-ton barge fleet, which is at the rate of 0.7 horsepower per ton carried, or just one-half the rail estimates. The above data was obtained from New York, New Haven & Hartford Railroad performance, but locomotives of much larger horsepower are required when there are steep grades to overcome. The barge route has no grades.

Since the railroads many times stated emphatically that they must have an increase of 25 percent or more in their freight rates to carry on successfully, then it would appear that the rate quoted by them before the increase was practically the cost to them of operation, including all overhead, interest charges, taxes and maintenance of way.

It can easily be seen that with power required cut in half, with maintenance of way avoided, with no land property to tax, and the inefficient tow line replaced by the economical application of electricity, the comparatively low rate of cost per ton for haulage is reasonable to expect and will very likely be still further reduced.

France Restores Her Fleet

FRANCE has made rapid progress toward restoration of her merchant marine. According to the Rapport Générale sur l'Industrie Francaise, which has just reached this country, the total French merchant tonnage on December 31, 1919, was 2,400,896 tons, or approximately the same tonnage as previous to the war, about 342,497 tons being under the Government's control. To this must be added the tonnage of the German ships provisionally under the French flag, and eventually to be permanently alloted to the several shipping companies by the Government.

Up to January 1, 1920, orders had been placed with French shipyards for the construction of 513,119 tons of ships. Since then 30,000 tons have been purchased from outside sources.

In his report to the Chamber of Deputies, Admiral Bienaimé, Deputy, asked whether or not the private French shipyards would be able to deliver, by July 1, 1922, the 669,000 tons, orders for which were contemplated. He answered the question by quoting a statement on the subject furnished him by the Minister of Merchant Marine.

This statement was to the effect that the private yards would be able to deliver the following tonnage: 1919-20, 310,000 tons; 1920-21, 445,000 tons; 1921-22, 500,000 tons, or a total of 1,255,000 tons; and, further, that at that time orders had already been placed for 729,000 tons, 215,000 tons of which were for Government account and the remainder for shipowners, leaving a construction capacity of 526,000 tons available for new orders.

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Heeling Ships

BY I. C. HANSCOM

This article deals chiefly with the practical side of heeling, because some experience is needed in order to have the experiments successful, and also because few papers discuss the subject from this point of view. Co-operation in some fifty experiments is the basis of the following information; diagrams have been included to supplement the text, and through the courtesy of Naval Constructor John G. Tawresey, U. S. N., I am able to give a short description of a method, originated by him, of heeling boats and launches in the air.—THE AUTHOR.

THE amount of ballast needed for inclining a ship must be estimated approximately, and then suitable places for it may be selected on the ship. It may be located where most convenient—forward, aft or amidships. Its location does not affect the accuracy of the experiment.

Plumb lines may be hung anywhere on the ship. They do not have to be on the centerline, although it is often convenient to place them there. Long lines give better results than short ones; therefore they should be made as long as possible.

A calculation of all the dunnage on board and its center of gravity must be made; and, as it is one of the most troublesome things encountered, good judgment and care should be used. At the same time a list of all material necessary to complete the ship may be prepared. It is also necessary to have the amount and center of gravity of all liquids, and the surface of any liquids free to move.

See that there is a rowboat ready to be used in taking the draft of water, unless draft gages are fitted in the vessel.

Make arrangements for moving the ballast to and from the ship, installing plumb line frames, emptying tanks and double bottoms, handling the lines and shifting the heeling weights.

DETAILS OF PRELIMINARY WORK

Knowing the amount of ballast,* we must decide what kind to use and how to handle it in the experiment. When pig iron is employed it may be placed in piles and handled across the deck by laborers. In this case, care should be taken to have the pigs as nearly uniform in size and shape as possible, otherwise it is difficult to estimate the center of gravity. The pigs should be piled neatly and not just thrown in a heap. They may also be arranged in buckets or skips and shifted by means of a crane. Scrap iron may be used, but it is not so easy to find the center of gravity, and in some cases heeling experiments on a small scale are made on each bucket to get the center. Pigs nicely piled on heavy trucks and rolled across the deck can be used, the trucks being held by tackles to prevent their getting beyond control.

Ships have been heeled by hoisting heavy weights from floats moored alongside. This necessitates strong davits or beams lashed across the decks and projecting over the sides of the vessel, the center of gravity of the inclining weight being at the point of attachment of the falls to the davits or beams. In this case any kind of ballast may be used, only the weight of it being needed. Moving guns, boilers, men and heavy machinery, also filling and emptying tanks, are some of the more unusual methods of heeling.

Plumb lines are usually hung in the hatches, because longer lines can then be used. They should swing free and not rub against anything. Light wooden battens are tacked to a frame fastened in the hold to mark the swing of the plumb lines. These battens should just clear the lines and be long enough to take the greatest swing of the bobs. Each batten may be marked "Port" and "Starboard," for in most cases the battens are removed to the office and measured there, and it is necessary to know which swings are to starboard and which to port. Sometimes tee squares are made reaching from the upper deck to the hold to support the bobs and are quite elaborate and costly, but ordinarily a wooden beam across the hatch and a frame down below is sufficient. If the heel of the vessel before the experiment starts is wanted, a line parallel to the centerline of the ship must be marked on the frame supporting the plumb line (see diagram Fig. 6). Practically all that is needed is a mark on the removable batten in the hold, the same distance from the centerline of the ship as the hook or nail which supports the plumb line.

The weight of the dunnage is usually estimated, for it can rarely be weighed. For this reason it might be wise to take that part of it first, the weight of which is fairly well known, and then collect any information obtainable on the rest. Even then, the man making the calculations is apt to wonder if the weights have been over or under estimated all through.

To get the weights necessary to complete the vessel, one must have a list of everything on board when she is finished. In case the ship is new, a book of specifications is the best thing, the items being checked off as the work proceeds. Getting the weight of the water and oil is not very hard, if the tanks and double bottoms are full, but if only partially filled, which is usually the case, it makes a lot of work. In a large ship with a rather flat bottom, the surface of the liquid in a tank, which has only four or five inches of water or oil in it, cannot be taken from the plans with satisfaction. It is well to remember that the workmen in the yard do not, as a rule, take measurements as closely as men in the office. For instance, in sounding a tank or double bottom compartment, they very often take the nearest inch as being close enough. Sometimes they will call a tank empty which has three inches of water in it.

The water in the machinery and boilers must not be overlooked, nor must the cylinder and lubricating oil be forgotten. There should be an examination of the paint and oil rooms and the storm oil tank, as well as the fresh and salt water systems and any gasoline which may be stowed on deck.

Unless the vessel is fitted with gage glasses for reading the draft of water, a rowboat should be ready for this purpose. If the ship is listed, the draft should be taken on both sides, then the mean of the readings will be the draft.

Allow several days for the mopping up of the tanks, if that work is to be done. It will be well to make sketches of the plumb bob frames for the carpenters, then they will know just what is required and the man in charge will get what he wants. If the ballast is to be man-handled across

* See any good text book on naval architecture.

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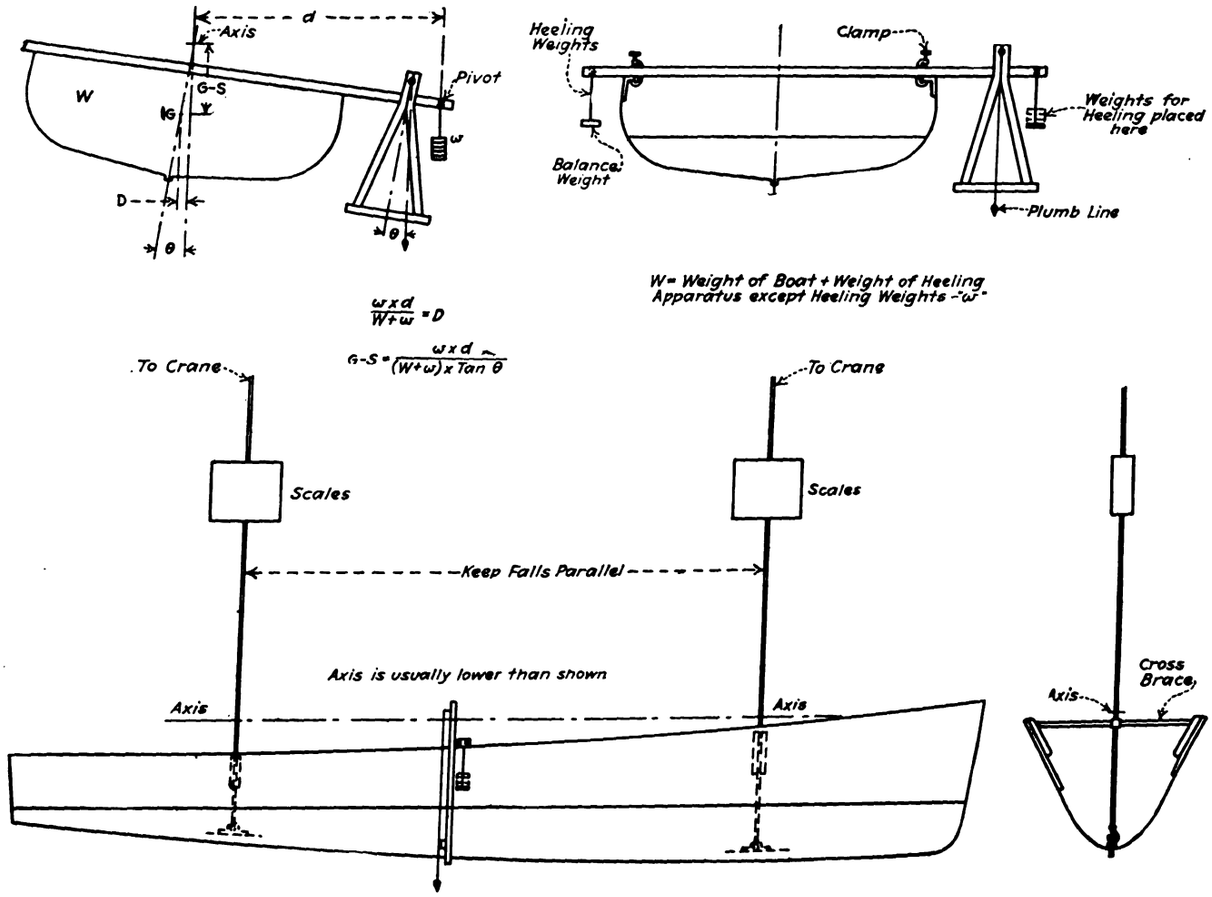

Fig. 1.—Diagram Showing Method of Heeling, Boat Acting as Weight of Pendulum

the deck, care should be taken to have enough men to move it quickly.

THE INCLINING

Everyone not actually engaged in the experiment should be ordered off the vessel and all those on board should be weighed. The weighing can be done while the draft of water is being read, then the weight of the observer may be taken. The fore and aft centerline of the ship should be marked on the deck with chalk, and the workmen should stand on this line during the reading of the plumb lines.

The men who are at the plumb bobs should be instructed how to mark the battens, so that number one reading, for instance, will be on each batten and denote the result of moving weight number one a certain distance across the deck. While the men are being instructed and are taking their places, the gangplank may be removed and some laborers stationed ready to slack off all lines from the ship to the wharf when the order is given.

At this stage of the heeling the conditions should be about as follows: The ballast should be in place ready to be moved; down in the holds the men should be at the plumb lines, one man at each line, ready to take readings; the gangplank should be removed and the men who are to slack off the line should be at their posts. The rest of the laborers should be near the ballast, ready to move it at the given signal.

The man in charge of the experiment should be where he can best see all the operations and can quickly receive the reports from his subordinates. He usually has a couple of draftsmen who call down to the men at the plumb lines when they are to take readings, and also measure the distance the heeling weights are moved and their centers of gravity above the deck.

The foreman of the laborers should be nearby the man in charge, so that he may transmit the orders to his men quickly. The first order should be to slack away all lines. When this is done, the next should be to mark zero number one on the plumb line battens (there may be more than one zero mark). Next, the slack should be taken in on the forward and after lines, one line forward and one aft is usually sufficient. Then the ballast should be shifted and frequent inquiries made of the men at the bobs as to how far they have swung. When about three inches of heel has taken place, the laborers at the weights may stop and return to the centerline of the ship, and a record may be made of the distances the weights were moved and their centers of gravity above the deck. The hawsers should now be slacked off forward and aft and another reading taken on the battens, which may be marked number one. The men at the plumb lines should be cautioned not to mark the battens while the ship is rolling, which often happens just after the weights are moved, but to wait till she steadies down.

When all the battens have been marked, the slack of the forward and after lines may be taken in, the weights moved again and new readings taken. The rest of the experiment is simply handling the lines, moving the ballast and taking readings at the plumb lines.

DUTIES OF MAN IN CHARGE OF HEELING

In taking charge for the first time, it would be well to write in a notebook the things that are to be done, in their proper order. The list may be checked up before the inclining takes place, to see if anything has been omitted. It may prevent the mortification of having ordered the zero points to be marked on the battens before the lines

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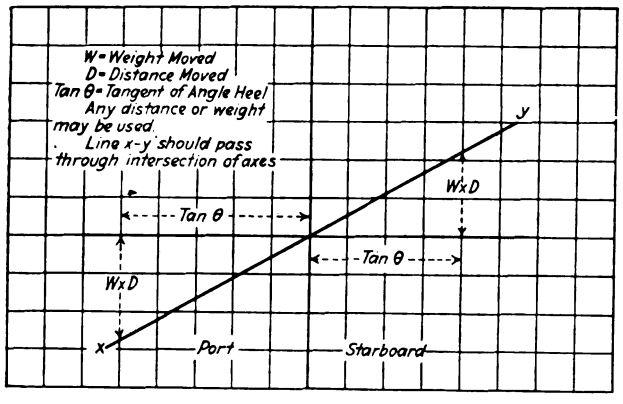

Fig. 2

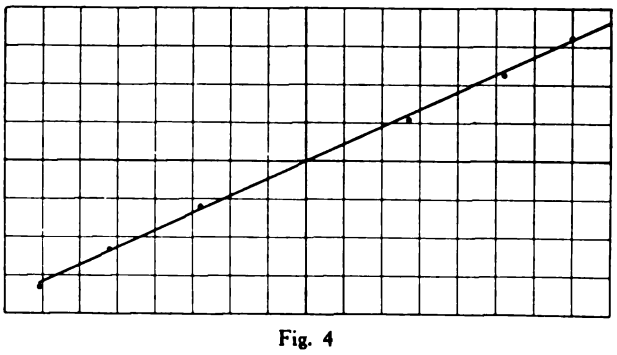

Fig. 4

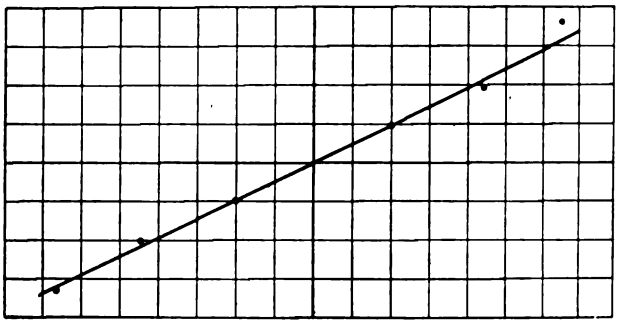

Fig. 3

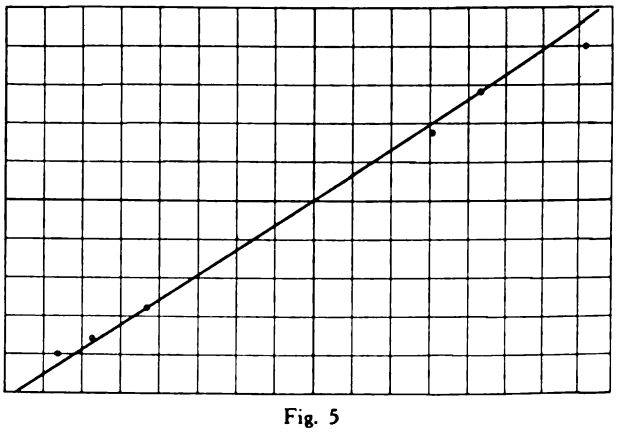

Fig. 5

have been cast loose. Other things should be written in the book such as a general description of the condition of the ship at the time of heeling; the size, number and location of the hawsers; the condition of the double bottom, tanks, peaks, water in the boilers and machinery, if any; the time of day, draft of water, density of water, amount of wind, condition of tide, number of men on board with their weight and where they are stationed—in fact, everything which affects the experiment except the dunnage and the detailed calculations of the liquids, which had better be separate.

Difficulties Likely to be Encountered

Pig iron varies considerably, and unless care is taken to pick out pieces weighing about the same amount it is hard to estimate the center of gravity when the iron is placed in piles. When buckets are filled with iron it is troublesome to find the vertical center of gravity. As a matter of fact, it is guessed in most cases. Perhaps no great error occurs, but it is better not to do this.

The heeling weights are apt to be late in arriving at the ship. Why they are the writer does not know, but in a majority of cases this occurs. The ballast should be weighed some time before the experiment, as the scales may break at the last moment.

Not enough time may be given the carpenters for making and installing the frames for the plumb lines, particularly if the list of the ship is required, for in that case slight changes in location of the frames may be necessary after they have been fastened in place.

Cleaning out the double bottom tanks or peaks is bothersome to the men and is likely to be slighted. Many times they cannot be entirely cleared and estimates must be made for free surface of liquids. It is better for the operator to put on overalls and rubber boots and make sure what the conditions are.

The water in the machinery, boilers and fresh and salt water systems should be checked up just before heeling, because they are subject to changes at short notice.

Sometimes the experiment has to be made when a strong wind is blowing, which prevents slacking off the hawsers, or there may be unavoidable delay, resulting in heeling the ship in a strong tide. Where no draft gages are fitted,

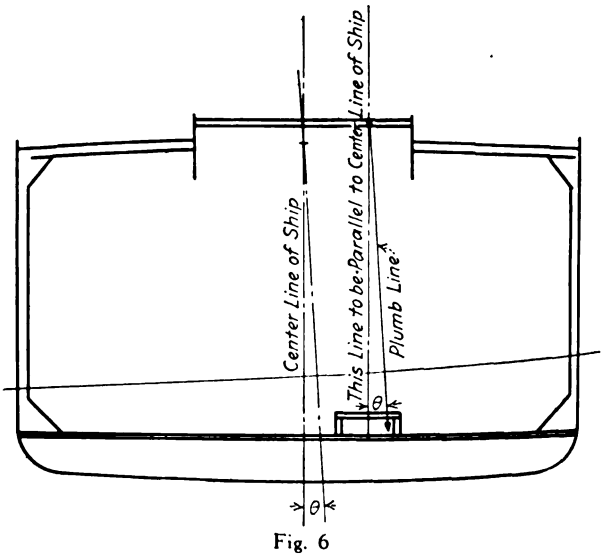

Fig. 6

waves may make the reading of the draft of water uncertain. The results depend on so many men that there is pretty sure to be something wrong, unless extreme care is taken to follow up every order and see that it is being carried out.

Naval Constructor Tawresey's Method of Heeling

Naval Constructor John J. Tawresey, U. S. N., designed an apparatus to be fastened to a boat in such a way that the boat became the weight at the bottom of a pendulum. This pendulum, instead of having one rod supporting the

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weight, had two—one forward and one aft. These rods were adjustable both vertically and athwartships, so that the axis of rotation might be parallel to the waterline or the bottom of the keel in a fore-and-aft line, and exactly amidships in the athwartship direction. A beam was clamped across the boat amidships, Fig. 1, and ordinary iron weights such as are used on scales were placed on a hanger at either end. The beam was made to project over the boat more on one side than the other, to allow a tee square to be fastened to it for hanging the plumb line.

Two traveling cranes, each having a heavy pair of scales attached, picked up the boat. Reading the scales at each crane gave the weight of the boat and allowed for fore-and-aft position of the center of gravity to be determined, correction being made for the weight and position of the heeling apparatus. The heeling was done by putting weights on the hangers of the beam carrying the plumb line. The result of the heeling was the distance from the center of gravity to the axis of rotation.

The advantage of this method is the ability to get the absolute weight and center of gravity of the boat, both vertically and longitudinally. Undoubtedly it is the most accurate way of heeling yet devised. It is limited to the size and weight of boat which can be hoisted in the air. Fig. 1 gives a general idea of the arrangement. The heeling apparatus shown in Fig. 1 has been improved by Naval Constructor Tawresey, but the principle is the same as that shown.

CONCLUSION

It is evident that considerable work has to be done before the actual inclining takes place; moreover, unless this work is done properly the results of the heeling may be impaired.

Experiments vary because conditions vary—not only in different yards, but in the same yard—and no two ships are in precisely the same condition when heeled. The kind of ballast on hand at the time may determine the method of inclining, and the man in charge adopts what seems to him the proper arrangement.

Most heeling experiments are conducted under more or less adverse conditions, and the results are usually approximate, but close enough for practical purposes. Indeed, it is a question, apart from ascertaining the actual center of gravity of the ship, whether the results with some free water on board are not more reliable than when the vessel is heeled dry.

As an aid in determining which readings of the plumb lines are correct and which are incorrect, Fig. 2 is appended, and examples of its use are shown in Figs. 3, 4 and 5. Fig. 6 shows a particular case in hanging plumb lines.

Shipbuilding Economies

(*Concluded from page 879.*)

burned. Excellent results can be obtained with oil forges if the rivet heater is skillful, as the temperature of the heating chamber can be accurately regulated and the rivets in the heater are in plain view. An experienced heater can tell at a glance when the rivets are hot enough to drive.

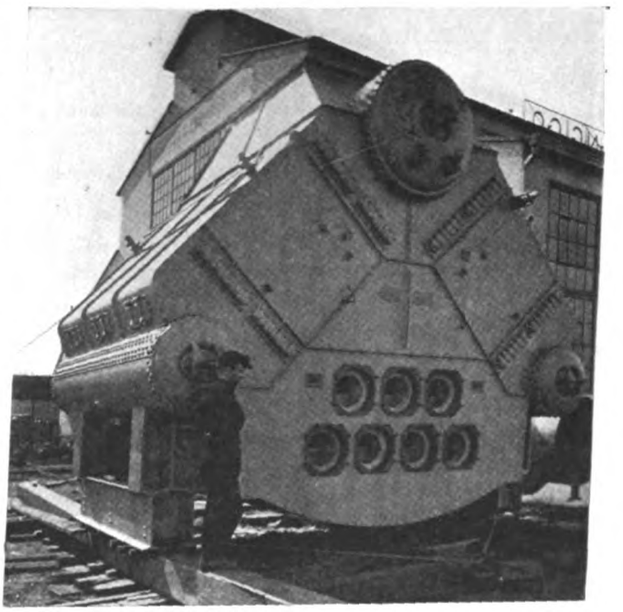
Coal forges are not used at the Puget Sound yard because the coal available in this locality clinkers so badly that fires must be cleaned at least twice a day. This delay is fatal to efficient riveting.

Coke forges similar to that shown in Fig. 22 are the most satisfactory fire for rivet heating, in the opinion of this navy yard. The coke is purchased already broken into nut size so that there is a minimum of labor in connection with its utilization, and the fire has to be deep in order that there will be sufficient "volume" of heat.

Ludlum Marine Watertube Boiler

Built for the United States Naval Experimental Station at Annapolis, Md.

OF special interest, because of its large size and extremely high pressure, is the boiler illustrated, which is 15 feet high, 17½ feet wide and 12 feet deep, with a furnace volume of approximately 500 cubic feet. Its weight is 85,000 pounds complete. The boiler was built for a working steam pressure of 350 pounds per square inch and tested to 550 pounds hydraulic pressure. The steam drum is 48 inches by 12 feet, with a tube sheet



Ludlum Watertube Boiler, Built to Carry 350 Pounds Working Pressure

1 13/16 inches thick. The water drums are 30 inches by 12 feet, with tube sheets 1 13/16 inches thick. All drums have double butt strap and double riveted joints.

The tubes are of cold drawn seamless steel, No. 10 gage, 1⅝ inches outside diameter. Surrounding the boiler is a casing of No. 10 gage steel plate backed with asbestos mill board and 2 inches of high-tempered special insulating material. The combustion chamber has a 9-inch fire brick lining backed up with the same insulating material mentioned above. The bottom of the furnace is shaped on the arc of a circle to allow for the proper expansion of the brick lining.

The unit is equipped with cleaning openings for each bank of tubes and also with Ludlum automatic soot blowers, the latter being operated by a chain pull. They automatically dispose of water of condensation in the piping and also shut off the steam automatically after cleaning is completed.

This boiler was too large to be shipped by rail and it was therefore transported on a barge, completely assembled. On arrival at the Naval Station it was necessary only to set it on its foundation and connect up the piping and smoke stack. No mason work or boiler setting was required.

This equipment was built in the shops of the New York Engineering Company at Yonkers-on-the-Hudson, New York, where a battery of boilers of this same type is now under construction for the United States Navy, each unit of which will be much larger than the one here described. When completed, they will be installed in one of the new battleships now under construction.

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General Formulae for the Vertical Position of the Center of Buoyancy

BY L. PISTNER, C.E.

THE necessity for a rapid determination of the vertical position of the center of buoyancy frequently arises. For this purpose Normand's, or, as it is sometimes called, Morrish's formula, is generally used. This formula is:

$$Z_0 = d - \tfrac{1}{3}\left(\frac{d}{2} + \frac{V}{A}\right),$$

in which

Z_0 = height of center of buoyancy above the under side of flat keel, in feet.
d = mean draft in feet to load waterline.
V = volume of displacement to load waterline, in cubic feet.
A = area of load water plane, in square feet.

It was this formula which served as the basis for the relations between beam and metacentric height established by F. M. Hiatt in the July, 1920, number of MARINE ENGINEERING. In the latter article it was stated that the formula had been applied to a large number of ships and found to yield very accurate results, the error usually being less than one-tenth foot and seldom greater than two-tenths foot.

It is the intention in the present article to develop formulae covering the extremes of cases to be met with in practice and to indicate the range of error to be expected from the application of Morrish's formula to these extremes.

Referring to Fig. 1, consider in the general case the forward body referred to the axes X, Y, Z (X and Y being in the horizontal plane and Z at right angles to this plane), AOB being the maximum midship cross-section, ABC the water plane section, and the curve OC the under side of keel and stem.

The case shown represents one extreme in which there is no parallel body whatsoever. The opposite extreme is evidently that of parallel body continued throughout the entire length. For this extreme case Morrish's formula gives:

$$z_0 = d - \tfrac{1}{3}\left(\frac{d}{2} + d\right) = \frac{d}{2},$$

since $\dfrac{V}{A} = d$ for a rectangular solid, which result is *exact*.

It is now required to derive an expression for the vertical position of the center of buoyancy for the case of the figure. In order to permit of algebraic treatment it will be necessary to assign to the curves of keel, load waterline and midship cross-section, that is, to OC, AC and AO respectively, equational relations by means of which these curves may be referred to the axes of reference. For our purpose it will be assumed that these curves are *parabolas*, the vertices of which are located at points O and A; that is, the tangent to OC at O will coincide with the X axis, while the tangents to the load waterline at A and B will be parallel to the X axis.

It will be understood that the choice of the parabola for this purpose is a matter of convenience in calculation and that such choice in no sense invalidates the generality of the method. Any other curve satisfying the necessary conditions as to tangency and passing through the designated points would have delineated the surfaces equally well, but would have led to unduly cumbersome algebraic work. For this reason the parabola was chosen.

Since OC is a parabola, its equation may be written:

$$z = K_1 x^2,$$

where K_1 is determinable from the condition $z = d$ $x = L$, whence

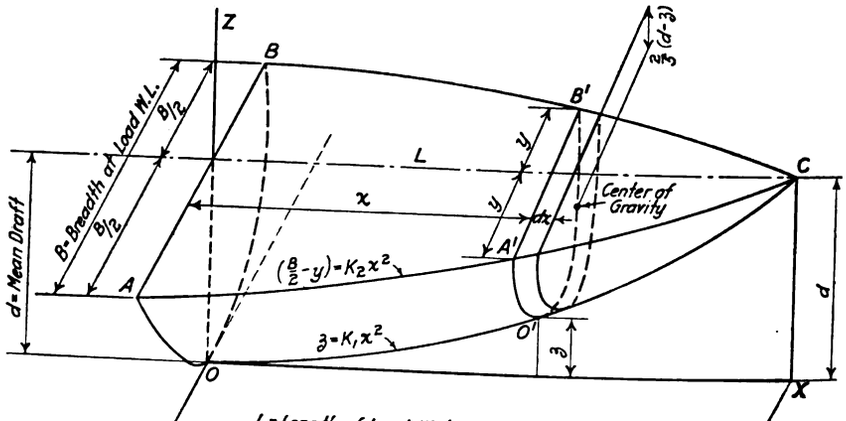

Fig. 1.—Forward Body, Convex Surfaces Throughout

$$K_1 = \frac{d}{L^2}.$$

Similarly for AC,

$$\left(\frac{B}{2} - y\right) = K_2 x^2,$$

where

$$K_2 = \frac{B}{2L^2},$$

since $y = o$ when $x = L$. Considering now any cross-section A' O' B' distant x from the midship cross-section, the area of the former may be written:

$$\tfrac{2}{3} \cdot 2y \cdot (d - z),$$

since the area of a parabolic segment is equal to two-thirds the product of the width and height.

The center of gravity of a parabolic segment being three-fifths of the total height from the vertex, the lever arm of the area with respect to the X axis becomes:

$$z + 3/5\ (d - z) = 1/5\ (2z + 3d).$$

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The moment of differential slab of base $A'\ O'\ B'$ and of thickness dx about the X axis may then be written:

$$dM = \tfrac{2}{3} \cdot 2y \cdot (d - z) \cdot 1/5\ (2z + 3d) \cdot dx,$$

and

$$M = 2/15 \int_0^L 2y \cdot (d - z) \cdot (2z + 3d) \cdot dx,$$

whence we obtain as an expression for the vertical height of the center of buoyancy above the X axis:

$$z_0 = \frac{M}{V} = \frac{2/15 \int_0^L 2y \cdot (d - z)\ (2z + 3d) \cdot dx}{\tfrac{2}{3} \int_0^L 2y \cdot (d - z)}.$$

Substituting values of Z and Y in terms of X, and values of K_1 and K_2 in terms of B, L and d, expanding and performing the indicated integrations, we obtain:

$$z_0 = \frac{2/15 \cdot 184/105 \cdot Bd^3L}{\tfrac{2}{3} \cdot 8/15 \cdot BdL} = 23/35d = \underline{\underline{.6571d.}}$$

Now applying Morrish's formula to this case, we have, since

$$V = \tfrac{2}{3} \cdot 8/15\ BdL$$

and

$$A = \tfrac{2}{3}\ BL,$$

$$\frac{V}{A} = 8/15d$$

and

$$z_0 = d - \tfrac{1}{2}\left(\frac{d}{2} + 8/15d\right) = 59/90d = \underline{\underline{.6556d.}}$$

from which it is seen that for the extreme case of no parallel body, but with convex surfaces throughout, Morrish's formula yields results the error of which does not exceed $.0015d$. For a draft of 30 feet the error is less than $\tfrac{5}{8}$ inch as far as convex forebody is concerned. But it was previously shown that Morrish's formula gives an *exact* result for the limiting condition of a rectangular form. It follows, therefore, that for all forms to be met with in practice, varying between parallel body and no parallel body, the error due to the use of Morrish's formula will not exceed $.0015d$, provided only that all surfaces are convex.

It remains, therefore, to consider the effect of concave surfaces as modifying the above conclusion. The concave surface is exemplified by the hollow *run* in most ships and by the hollow *entrance* less frequently.

Referring now to Fig. 2, in which CD is the sternpost, AOB the maximum cross-section of concave lines, and $A'\ O'\ B'$ a cross-section intermediate between the latter and the sternpost, and taking AO and OB as parabolas with vertices at O and AC and CB with vertices at C, we obtain by a method entirely similar to that already presented:

$$Z_0 = \tfrac{3}{4}d = .7500d \text{ by the exact method,}$$

and

$$Z_0 = 13/16d = .7222d \text{ by Morrish's formula,}$$

from which it is seen that for the case of concave surfaces there is a maximum error of $.0278d$ by the use of Morrish's formula.

Considering all types of merchant and passenger ships, it will be found that the volume displaced by those underwater sections of the hull which are *wholly concave* bears to the volume displaced by those sections which are either straight line or wholly convex, a ratio which never exceeds 1:6. For such ships as a whole, therefore, the maximum error resulting from Morrish's formula will be:

$$(.0015d \cdot 6 + .0278d \cdot 1) \div 7 \cdot .0053d,$$

which for ships of 30-foot draft is *less than 2 inches.*

This error is probably less than that to be expected in ordinary forms of computation unless extraordinary precautions are observed. It is therefore suggested that Morrish's formula may with propriety be used for final as well as preliminary work.

In closing it may be stated that the method here presented of approximating the lines of the hull by parabolic segments, the parameters of which are determined by the limiting conditions of tangency and general dimensions, will be found extremely useful in a large number of practical as well as theoretical problems, as, for example, in determination of volumes of fore and aft peak tanks, transverse and longitudinal metacentric height, etc. The results obtained will be found surprisingly accurate.

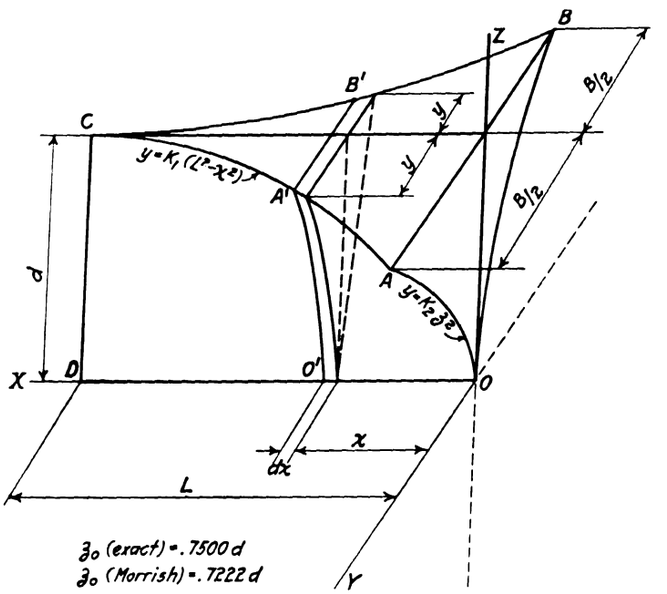

Fig. 2.—After Body, Concave Surfaces Throughout

S. S. Belgic to Enter Belgian Passenger Service

BERTHED at Pier 61, North River, New York, recently was the world's largest freighter, the *Belgic*, of the International Mercantile Marine Company's fleets. The *Belgic's* deadweight capacity is something more than 22,000 tons. She is 670 feet long and 78 feet beam. Her registered tonnage is 24,547 gross and she burns oil. Designed as a combination passenger and freight carrier of the Red Star Line's service between New York and Antwerp, and built at Belfast, the *Belgic* was finished up hastily in 1918 and rushed into service as a trooper. Since the close of the war she has been operated under the White Star flag.

It is stated that she will soon be taken in hand for completion as originally designed, by the addition of two decks to embody the latest features in passenger carrying equipment, and that as the *Belgenland* (her original name) she will be put into the Red Star Line service when the work is completed. She will be the largest ship to ply to a Belgian port.

PHILADELPHIA MARINE EXPOSITION.—The American Marine Exposition will be held in the First Regiment Armory, Philadelphia, March 14-19, 1921, under the management of the American Exposition Company, 803 Real Estate Trust building, Philadelphia.

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The Effects of Holes, Cracks and Other Discontinuities in Ships' Plating*

BY PROFESSOR E. G. COKER, D. SC., F.R.S., AND A. L. KIMBALL, M.E.E.

THE present paper is an extension of the subject matter of two former papers† in the Transactions of the Institution of Naval Architects, in which the effects of various discontinuities were examined to find the alteration in the stress distribution produced thereby, principally in tension members. It confirms, in general, some of the principal results of the mathematical theory of the stress around an elliptical hole in a wide plate, which formed the subject matter of a paper‡ by Professor C. E. Inglis contributed in 1913. Viewing a crack as the limiting case of an ellipse, in which the minor axis is vanishingly small, it is easy to show, both from calculation and experiment, that a crack inclined to the direction of stress produces a great concentration, which approaches an infinite value. A practical way of reducing the stress intensity is to drill out the ends of the crack, and the experiments described here show what effect this produces, and also the change in stress produced, by forming elliptical cavities at the ends instead of circular holes.

At the date of the earliest of the papers mentioned above the stress which occurs in deck plating at a hatchway was also examined, but only for the purpose of determining the stress across the weakened principal section, whereas the principal point of interest arises at the change of section of which some measurements are now contributed, to show how great is the stress experienced at the joint of the diminished section to the main body of the member.

The experimental methods used have been sufficiently described before, and it is, therefore, only necessary to recall that the complete determination of stress in a plate subjected to loading in its own plane can be completely solved experimentally without reference to any theory of stress distribution, provided it may be assumed that the plate is not so thick as to cause a variation of stress across the section, and for applications to other materials that load systems applied to each edge boundary are in equilibrium separately, as is the case in all the examples described here.

If these simple conditions are fulfilled, the solution of any stress problem at a point in a plate, whatever may be its form, can be determined by three sets of measurements. There are:

(1) The directions of the principal stresses P and Q.
(2) The value $(P - Q)$ from an optical measurement.
(3) The value $(P + Q)$ by a mechanical measurement.

It is possible, however, to dispense with the third measurement in a complete solution, but it is generally more convenient to obtain this. In many practical problems, however, one or more of these measurements can be dispensed with. For example, at a point along a boundary where there is no applied load, the values of $P \pm Q$ reduce to either P or Q, since the other stress must be zero, while the direction of the existing stress is along the boundary.

This latter case gives an important simplification, since in many instances the only important stress is at a boundary.

An interesting example is presented by the case of an elliptical hole in a plate in which the ratio of the length $(2a)$ of the major axis to the length $(2b)$ of the minor axis is varied between equality and infinity giving a circle for one limit and a fine crack at the other.

It is not proposed to consider circular holes here, except incidentally, as these have already been examined with some care. The case of the elliptical hole has not been examined experimentally so far as we are aware, although an exact solution is known for such a hole in an infinitely wide plate. In order to verify this theory, various elliptical holes were cut in a plate of clear nitrocellulose 5 inches wide and 0.155 inch thick, to which a uniform tension load was applied in a testing machine of three tons capacity. The arrangement for loading the test piece is of the simplest kind, Fig. 1, and consists of a pair of plates A secured to each end by a number of small pins B to distribute the pull applied by the machine through centrally placed pins C. The positions of the holes cut in this plate are indicated approximately in this figure.

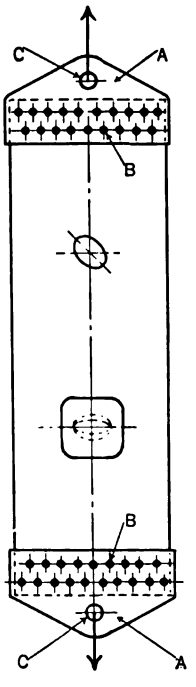

Fig. 1

In such an arrangement nearly the whole length of the uncut plate should be in pure tension, and this was found to be so, by optical measurements, except for a short distonce from the ends.

It was considered sufficient to examine three cases of elliptical holes, and these were selected somewhat arbitrarily by taking an ellipse with a major axis 1.125 inches long perpendicular to the line of pull, and having a minor axis 0.375 inch. This hole was subsequently altered to one with major axis 1.2 inches, and the minor axis was increased to 0.8 inch. In a third example this latter form of hole was intended to have the major axis at 45 degrees to the line of pull, but through an error in cutting out this line was found to have an inclination of 49 degrees to the line of pull, and was therefore somewhat inconvenient for calculation purposes. For convenience of reference in all these cases, any point A, Fig. 2, on the boundary of these holes is determined by means of the eccentric angle β for a circle described on the major axis as diameter. It will be convenient to describe the earlier experiments on an elliptical hole athwart the line of pull by reference to the less eccentric one first, although, as mentioned above, the

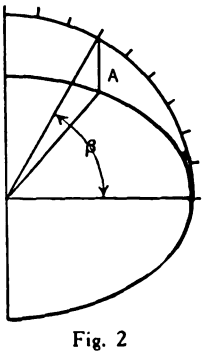

Fig. 2

* Paper read before the Institution of Naval Architects, March 25, 1920.

† E. G. Coker: "The Determination, by Photo-Elastic Methods, of the Distribution of Stress in Plates of Variable Section, with Some Application to Ships' Plating," Transactions of the Institution of Naval Architects, 1911. E. G. Coker and W. A. Scoble: "The Distribution of Stress Due to a Rivet in a Plate," Transactions of the Institution of Naval Architects, 1913.

‡ C. E. Inglis: "Stresses in a Plate Due to the Presence of Cracks and Sharp Corners," Transactions of the Institution of Naval Architects, 1913.

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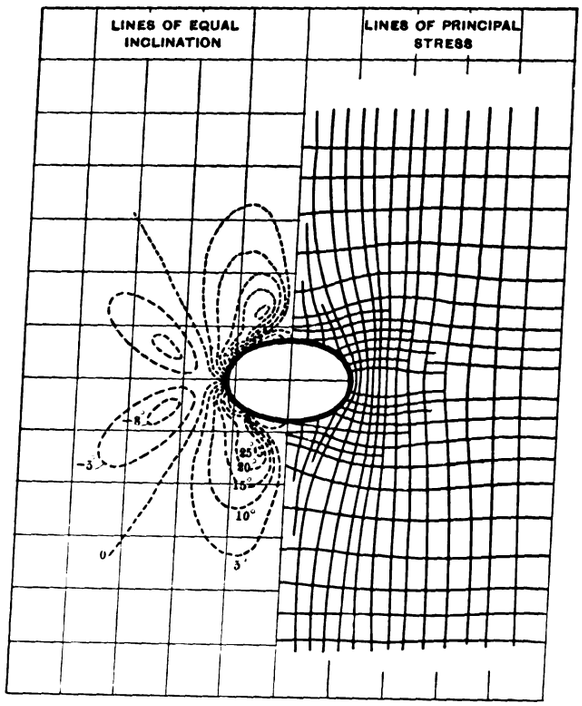

Fig. 3.—Elliptical Hole $\frac{b}{a} = \frac{2}{3}$

experiments were made in the reverse order to economize skilled workmanship and material. The general features of the stress distribution are apparent at once in the polariscope, the effect of a pull being to cause an intense stress at the ends of the major axis, and if the elliptical hole reduces to a fine slit, the region around the ends of this latter becomes very much overstressed at even a small load, and shows this on removal of the load by characteristic residual stress effects. It is also to be noticed that the directions of greatest stress intensity away from the hole approach the boundaries at a considerable angle to the axial line, and this leads to the belief that in a plate of narrow width the stress at the outer straight boundaries will be found to reach a maximum at two places equally distant from the line of minimum cross-section. An examination of a plate with an elliptical hole in it of considerable size shows this to be the case and confirms some recent measurements of the effects of moderate-

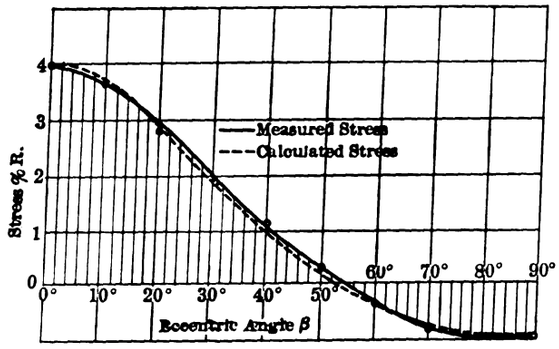

Fig. 4.—Stress at Boundary of Elliptical Hole, Case $\frac{a}{b} = \frac{3}{2}$

sized circular holes in tension members.* Apparently the stress at the minimum section of this latter member has, in general, maximum values at the inner boundary and minimum values at the outer one. In the elliptical hole the same effect is noticed, and is probably connected with the fact that in such a case the lines of principal stress, having a general direction parallel to the line of pull well away from the hole, curve first one way and then the other as they get farther from the hole, so that there must be a change in stress at the boundary if this latter is only a finite distance away. This effect is noticeable even in the present case, and the lines of principal stress, determined experimentally and shown in Fig. 3, exhibit this clearly. The lines of equal inclination, from which these curves are derived, are also marked on the left-hand side of the diagram. An examination of the stress at the elliptical boundary shows that its variation is very great. Commencing at the extreme end of the major axis, where the tensile stress is most intense, Fig. 4, it gradually diminishes to zero at a point having an eccentric angle of 54 degrees, and becomes a compression stress which reaches a maximum at the end of the minor axis.

A comparison of these observed stresses with the calculated values obtained from the appropriate equations of Professor Inglis's paper shows a gratifying agreement, as the figure shows, and affords a proof, if any were needed, that such calculations can be applied to any material which obeys the assumptions on which the mathematical theory of elasticity is based.

* E. G. Coker, K. C. Chakko and Y. Satake: "Photo-Elastic and Strain Measurements of the Effects of Circular Holes on the Distribution of Stress in Tension Members," *Transactions of the Institution of Engineers and Shipbuilders in Scotland*, November, 1919.

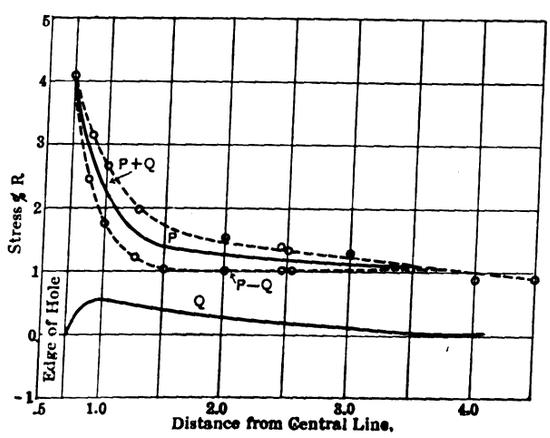

Fig. 5

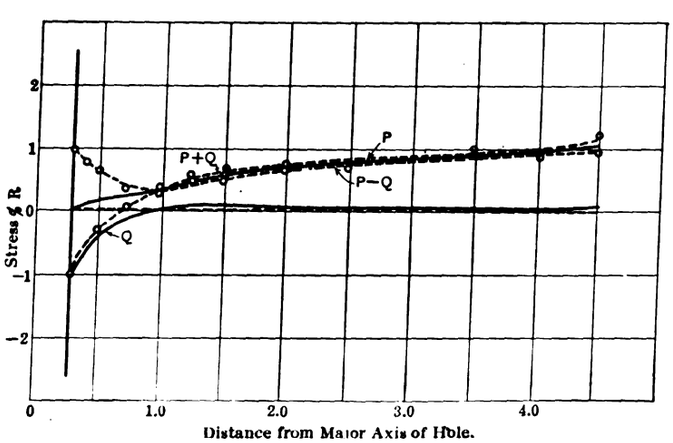

Fig. 6

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The distribution across the minimum section necessitates a complete analysis, which is provided by the curves of Fig. 3, together with the values of $P \pm Q$, expressed in terms of the appropriate mean stress R corresponding to an infinite plate, as shown on Fig. 5. The values of P and Q have been separated from these observations, and are

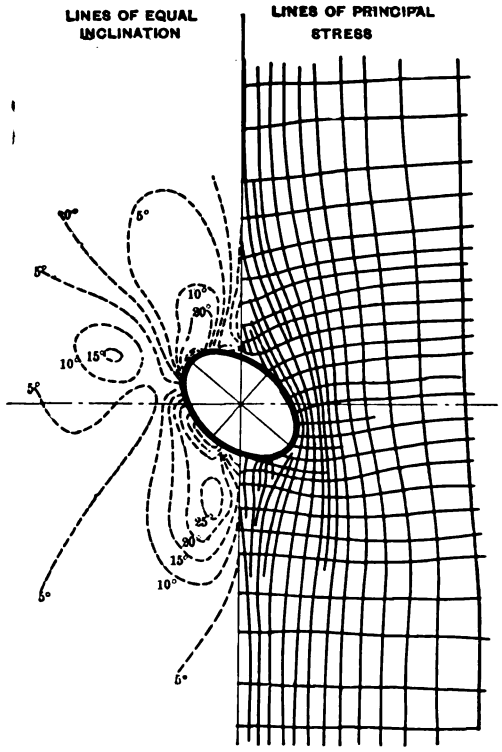

Fig. 7.—Elliptical Hole $\frac{a}{b} = \frac{3}{2}$. Inclination 49 Degrees to the Line of Pull

shown by firm lines. It will also be noted that in addition to the great intensity of the tension at the inner point of the boundary there is a perceptible tensional cross stress near the edge, and as the ellipse tends more and more towards a fine horizontal crack, the maximum value of Q increases and also approaches the boundary, although it can never actually reach it in any practical example.

It is interesting to trace the variation of stress along the central axis by observations of the values of $(P \pm Q)$ obtained in a like manner, and these latter are shown in Fig. 6, from which it will be observed that the axial stress is zero at the boundary of the hole and rises gradually to a constant value at a distance of about two inches away, while the cross stress is a compression approximately equal in value to the corresponding uniform tension, which rapidly changes to a small tension and ultimately disappears.

The case of the more elliptical hole also bears out these

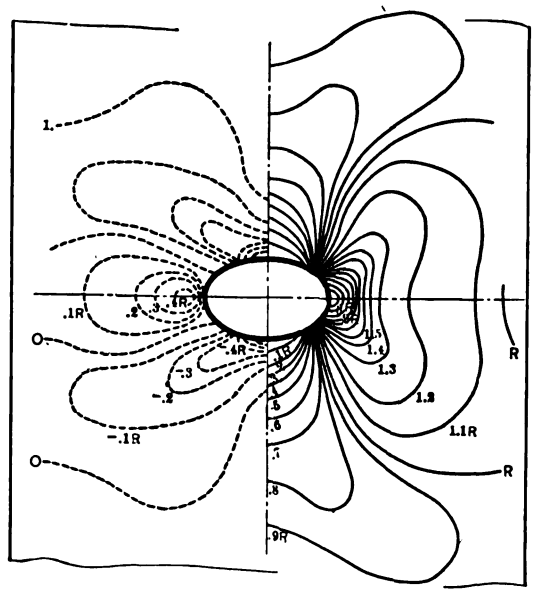

Fig. 9.—Contour Curves of Equal Values of P and Q

results, and, in fact, the values obtained confirm those described above, so that it is hardly worth referring to them in detail, except to point out that all the experiments for this type of hole agree in showing that the maximum stress is always approximately $(1 + 2\frac{a}{b})$ times the stress corresponding to that of the infinitely wide plate, where a and b are the appropriate values of the axes, and the hole is small.

The case of the elliptical hole inclined to the line of pull presents some interesting features not shown by the former cases. In the first place the maximum stress is not at the ends of either major axis, but is found at or near the point where the tangent line parallel to the line of pull touches the ellipse. The lines of stress, as may be surmised, only possess a bi-lateral symmetry, as is shown by the experimental determination, Fig 7, in which one also observes the tendency of the outer lines to bend outwards at some distance above and below the hole, and not in quite

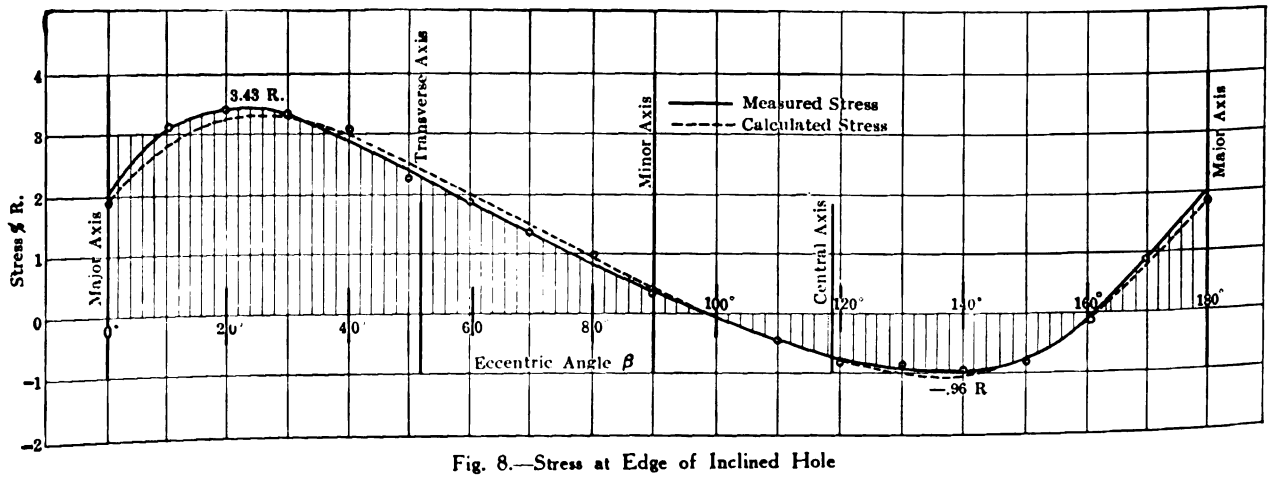

Fig. 8.—Stress at Edge of Inclined Hole

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the same way above and below the transverse central plane. They appear, in fact, to indicate maximum stresses at the outer straight sides at unequal distances from the central cross-section, and polariscope observation confirms this.

The stress distribution round the hole has been determined and compared with the theoretical expression of Inglis, and a very fair agreement is found, as Fig. 9 shows, in which the two are compared by plotting the stresses observed and calculated on a base derived from the eccentric angle β. The stress is found to vary between 3.43 R and —0.96 R, and is in good agreement with the theoretical expressions. It is also of interest to note that when the stress distribution is examined across the plane perpendicular to the line of pull and passing through the center of the ellipse, it is found to account for the total pull within one percent.

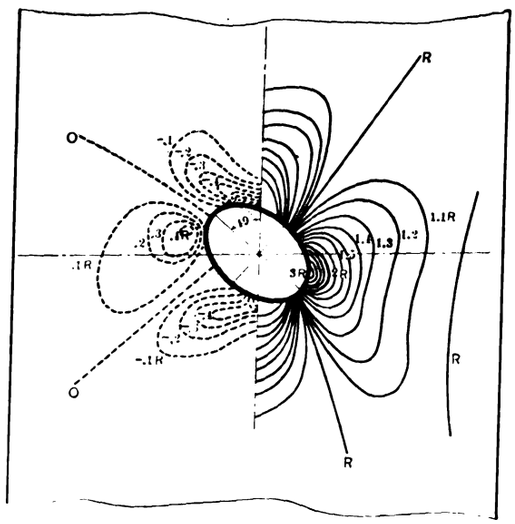

Fig. 10.—Contour Curves of Equal Values of P and Q

In the case of two of the ellipses studied, the stresses are determined at points along radial lines 22½ degrees apart, including the longitudinal and transverse sections. The values of P and Q are plotted and contour curves drawn, as shown in Figs. 9 and 10. The full line contours correspond to P magnitudes, and the dotted curves, shown on the left, to those of Q. For the transverse hole five sections are studied, to include one quadrant, and for the inclined ellipse eight sections, covering half of the area, are determined, in order to give the complete stress distribution. For the transverse hole there is quadrantal symmetry, and for the inclined one the symmetry is seen to be bi-lateral, corresponding in each case to the symmetries of the principal stress direction lines shown in Figs. 3 and 7. A noticeable feature shown by the P and Q contour curves is the great rapidity with which extreme values of stress fall off on leaving the edge of the hole. At a distance equal to twice the length of the major axis in any direction from the edge of the hole the values of P and Q have become substantially equal to those which exist at points remote from the hole. It is also to be noticed that where the stress at the edge of the hole is tension, the Q component vanishes, and where it is compression the P component vanishes, the transition points being the four points of zero stress. These points are indicated on Figs. 9 and 10.

CRACKS

The experiments described above have also an especial interest, since the effect of a fine crack can be estimated from these results. If we consider it as the limiting case of an ellipse, in which the minor axis ultimately vanishes, an infinite stress is produced at the extreme ends for any inclination which does not approach too nearly to the direction of the pull.

Practical men have long been aware of the extreme concentration of stress produced by such cracks, and have provided a well-known remedy for stopping their extension, which is universally used, whether it be for a crack in a steel forging or in a delicate piece of china. It occurred to the authors, however, that the method of drilling circular holes at the ends of a crack might possibly be improved upon. If circular holes of small size are drilled at the ends, the effect is to reduce the stress concentration from some unknown but very large amount to approximately three times the equivalent uniform stress in the uniform plate. From the preceding results it seems probable that there might be a further reduction of stress, if elliptical holes or approximations thereto are drilled at the ends of a crack, with their axes so arranged that the position of maximum stress occurs at the end of the minor axis. In order to test this view, a tension member was prepared 1.56 inches wide, in which four fine slits were produced transversely to the line of pull and symmetrically disposed with reference to the axial line. The forms of these slits are shown in Fig. 11, but they were actually spaced very much further apart in order to obtain uniform stress conditions in the intervals between them, and the contours of the holes were much larger than necessary for practical requirements in order to permit of a more accurate study of the stress effects produced.

The ends of the first slit A were left exactly of the form produced by a drill of 1/32 inch diameter, which happened to be available; the ends of the second B were finished with holes of ⅛ inch diameter; the third C with vertical slots of ¼ inch length, made by drilling ⅛-inch holes tangential to the centerline of the slit and afterwards removing the angles left by the drill. The fourth D was produced in a similar fashion, and the outer part curved to a radius of 0.22 inch to give an approximately elliptical contour.

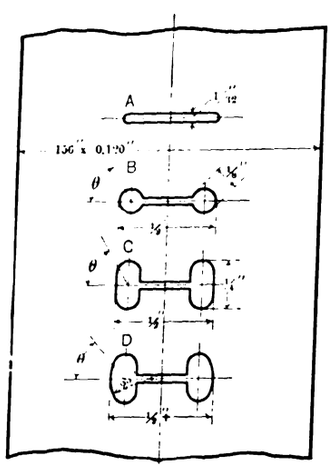

Fig. 11

The total width of the slit was ½ inch in all cases, except for D, and an allowance for the extra stress produced by the increase in the size of the latter is, therefore, made for comparison purposes. The specimen so prepared was then subjected to a load of 100 pounds (corresponding to a mean average stress of 790 pounds per square inch) in a small testing machine and the stresses round the contours determined for a sufficient number of points to make a comparison effective. The values so obtained are shown in Fig. 12, in which all are compared by aid of angles θ as abscissæ and stress as ordinates, so far as this is possible, and the remaining parts of the contours of C and D by linear measurements along the contour. The distances in the two latter cases are not quite the same, but the difference is not material. The comparison at once shows that for the simple case taken it is possible to materially reduce the high stress caused by a semicircular ending to a crack by drilling out a nearly complete circle, and proves the value of the practical means usually

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adopted, especially for a hair-line crack, where presumably the stress effect is very great. The substitution of form *C* effects a still further improvement by lowering the stress intensity from 2,250 to approximately 1,670 pounds per square inch, with a minimum value at an angle of $\theta = 15$ degrees approximately, and a minimum value at the central section of about 1,250 pounds per square inch. The form *D*, as might be expected, gave a maximum stress at the central line, and, as measured, corresponded to a stress of 1,700 pounds per square inch when the extra width was taken into account. Practically there seems little to choose between these two last forms, although the experiment is not decisive one way or the other. Having regard to the measurements on elliptical holes it is possible that form *D* is actually the best one to adopt if the proper shape of elliptical hole is chosen.

Stresses Around Hatchway Openings

It is unnecessary here to refer particularly to the case of a large circular hole in a tension member of finite width, as these have been examined in an earlier paper, but there are many other types of discontinuity which are of importance, and an interesting practical case to which shipbuilders have devoted considerable attention is that of hatchways in ships' decks. They are probably subjected to complicated load systems not easy to define or to produce in the laboratory, but a simple type of loading, such as that of a pull, serves at any rate to bring out some characteristic features. The chief places of interest in all such cases of sudden discontinuity appear, in general, to be at or near the sudden change of section, and the case selected shows this quite well, although it would probably be easy to obtain a more characteristic one.

This example consists simply of a square hole of 2-inch sides cut in a plate of 5-inch width and having rounded corners of half an inch radius, the sides being parallel and perpendicular to the pull.

The large radii at the angles were chosen with the object of getting precise measurements at points of this part of the contour, and are greater than is usual in practice. The maximum stress occurs at the interior contour and

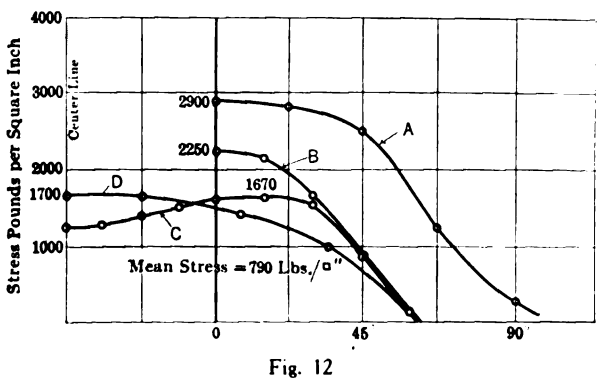

Fig. 12

near the joint of the rounded corners, with the sides parallel to the line of pull. There are also indications of a subsidiary maximum along the external contours at a considerable distance from the hole. These observations are amply confirmed by the measurements shown on Fig. 13, in which the stress distributions around both contours are shown for a total load of 390 pounds, giving a mean stress of 840 pounds per square inch at the reduced central section. In addition, the stress distribution across this latter section is shown by aid of observations of $(P \pm Q)$ shown in dotted lines, from which it may be observed that the cross-stress Q is negligibly small, while the maximum value of P at the interior contour along this section is 1,290 pounds per square inch.

Integrating the curve there shown and comparing it with the pull applied, it is found that the mean error of observation is approximately 3 percent, which is a useful test as giving an idea of the general degree of accuracy

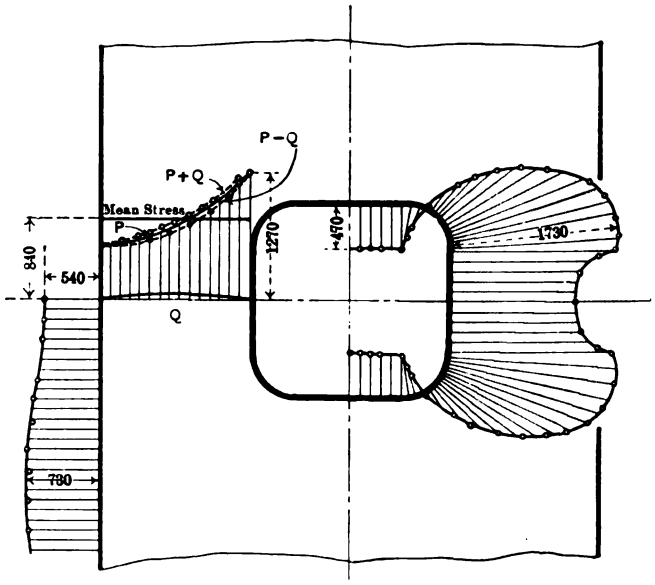

Fig. 13

obtained. The actual maximum is at the commencement of the angle and just beyond the joint of the straight and curved portions, with a value of 1,730 pounds per square inch, or 2.06 times the value of the mean stress at the central cross-section. It is also easy to show that as this curve lessens in radius the stress increases and becomes dangerously great, even with a moderate load.

As we pass still farther along the curve, the stress rapidly diminishes and finally changes sign and becomes a compression of fairly uniform value along the plane contours. The outer contours also show the characteristic feature, already mentioned above, for another case of a minimum value at the central section with maxima on either side, but in this case these latter values are not very pronounced owing to the distance of the hole from the outer boundaries.

It is probable that a study of other cases of hatchway openings of more immediate practical importance than the one described here would afford information of value in practical construction.

Correction.—On page 825 of the October issue of Marine Engineering there was published a photograph of a United States destroyer over a caption which describes the vessel as the U. S. S. *Satterlee,* giving the official figures for the speed and power of this vessel during her official trial. Inadvertently, however, the photograph reproduced on this page showed the United States destroyer *Cole* instead of the *Satterlee* described in the caption. The destroyer *Cole* was built by William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa. The propelling machinery of the *Cole* consists of twin sets of Parsons single reduction geared turbines supplied by the Parsons Marine Steam Turbine Company, Ltd., the reduction gears for which were supplied by the De Laval Steam Turbine Company, Trenton, N. J. According to unofficial figures supplied by the builders, the destroyer *Cole* during a straightaway top speed run maintained a speed of 41.1 knots.

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Fuel for Diesel Engines

BY C. H. PEABODY, DR. ENG.

For the development of a permanent American merchant marine the Diesel engine is most important if not absolutely necessary, especially for the most numerous class of ships, namely the moderate sized freighter. The adaptation to that service is now complete, and the engine has the advantage of fuel economy and of requiring a small engine room crew; more especially, it does not call for firemen. The supply of oil available for Diesel fuel is not unlimited, however, so a review of the various sources will serve to point out what may be expected in meeting fuel requirements as oil engines are further developed.

IT is interesting to consider what fuels are available for the Diesel engine, and what are their properties. The hot-bulb engine, sometimes called the semi-Diesel engine, has such resemblance to the Diesel that its requirements can be considered at the same time.

The usual fuels for these engines are:

Petroleum products; heavy distillates, gas oils and residues, and sometimes the crude oil itself.

Shale oils, either crude or heavy distillates.

Coal tars, either raw or heavy distillates, or in some cases crude naphthalene.

Petroleum comes first on the list and is first in importance at this time. Though everybody is familiar with the light distillates sold all over the country as gasoline, and with certain other products like kerosene and naphthalene, few know the raw oil which has a vile color and a viler smell. The composition of the oil is hidden by the chemists under such names as pentatriacontane, but a fair working idea of the essentials is not so hard, nor is it hard to grasp the differences of the various petroleums and other oils and of tars used in Diesel engines.

Characteristics of Various Oils

In this country we have the Pennsylvania oils which are thin with a paraffin base, and the Texan and Mexican oils which are thick with an asphalt base. The South American oils are like the Texan, and the East Indian are more like the Pennsylvanian, while the Russian oils are intermediate in quality, though having a notable chemical difference. Our ships, especially the ubiquitous tramp, are liable to become acquainted with all of them.

All the oils and tars that we are considering consist essentially of hydrocarbons—that is, of various combinations of hydrogen and carbon in all sorts of proportions; other matters, like sulphur, nitrogen and oxygen, occur in small quantities and may be treated as impurities. Sulphur, when in considerable quantity—say 3 to 5 percent—is sometimes troublesome, but it is said that it does not give trouble when the fuel is burned in a Diesel engine. Should there, however, be an appreciable amount of ash, or should free carbon be deposited, the trouble is liable to begin. This seems a little remarkable considering that Dr. Diesel expected to burn powdered coal in his engine and thought that the ash would not be important.

The Pennsylvania oil is said to have a paraffin base; more properly we should say that the oil consists of various members of the paraffin series. The chemists consider that this series begins with marsh gas or methane, which has one atom of carbon and four atoms of hydrogen. The series advances by adding successively one atom of carbon and two of hydrogen; for example, the fifth of the series is pentane and is written $C_5 H_{12}$. This is the principal constituent of righoline, which is the lightest petroleum distillate sold on the market, and which is used as a local anesthetic. Since it boils at 64 degrees F., it may be said to be a liquid in winter and a gas in summer. Natural gas begins with methane and goes down to pentane or even lower.

Gasoline is supposed to take on the distillates from 160 degrees F. to 300 degrees F., and kerosene goes from 300 degrees F. to 600 degrees F. Heavier distillates are used for lubricants, for enriching illuminating gas and as fuel for hot-bulb and Diesel engines. By the process of "cracking" the amount of lighter distillates can be much increased. Under the stress of demand for gasoline the range of temperature is forced at both ends and the heaviness due to encroaching on the kerosene distillates is counterbalanced by "livening up" with some of the series derived from natural gas.

The oils and waxes used as fuels for the Diesel engine are distilled within the range from 300 degrees to 600 degrees or more. Paraffin candles come about the middle of the range, and pentatriacontane is about the lower limit.

The various paraffins are known as saturated compounds and are stable and inert. The oils and waxes when pure are colorless and tasteless. From coal tar may be obtained the aromatic compounds benzene, toluene and naphthalene; they are unsaturated compounds and are less stable than the paraffins, which also burn more readily.

Naphthalene, which is a solid, can therefore be used to run the Diesel engine, if melted so that it can be atomized by an air blast. Trinitrotoluene, or T.N.T., is made from toluene, which is a liquid boiling at 230 degrees F.

The Russian oils are largely made up of a series of even more complex compounds which are chemically related to the aromatic compounds, but the fuel user will find that they appear to resemble the paraffin of the Pennsylvania oils. They have the property of being unsaturated and burn more easily than the paraffin, i. e., thicker oils can be worked in the Diesel engine. Having in mind the vile smell of raw petroleum, it is curious to find that certain products of the Russian oil are used in perfumery, but the vagaries of those using perfumes is beyond finding out, and we have in mind that civet was once so used.

Critical Temperatures of Oils

There are two very important temperatures for any fuel oil—first, the flash temperatures, and, second, the temperature of spontaneous ignition. The first has to do with safety, and the second with availability. Since crude oils are liable to contain all the compounds that are not gaseous at ordinary temperatures, and may hold some gases in solution, the flash temperature is likely to be low; that is, such oils are very dangerous. It is most strongly advised that such oils be avoided, and when circumstances force their use the greatest precautions must be observed; they are likely to be more dangerous than gasoline.

Now the Diesel engine commonly compresses air to 500 pounds, at which it has a temperature of 1,000 degrees F.,

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Then naphthalene, which has an ignition temperature of 750 degrees, gives no trouble. It appears that benzole, which requires more than 1,000 degrees, may be troublesome. Certain tar oils, to be discussed later, require a higher compression and temperature to ignite regularly, whereas the Diesel engine has already too heavy a compression for convenience. Petroleums and their products seldom give trouble in igniting unless heavy residues of asphaltic oil are used, but such fuels are objectionable on other accounts and should be avoided.

Combustion of Asphalt

A good deal has already been said about asphalt, and it may be interesting to remember that it is found in lakes and springs at the outcrop of petroliferous strata as at Trinidad, and is usually a viscous solid. A similar product may be obtained by blowing air through the hot residue left in petroleum stills. Asphalt, either natural or as found in petroleum or in tars, is soluble or partially soluble in the lighter petroleum distillates, but it cannot be distilled; on the contrary, it breaks up when heated, depositing free carbon. This is the essential reason why it gives trouble in Diesel engines.

The carbon deposited from an asphaltic oil gathers on the top of the pistons and it clogs the atomizing devices, and, worse yet, burning particles of carbon or coke attack the surfaces of the exhaust valves and the valve seats. At one time this action was attributed to sulphur, which may attain a percentage of four or five, but it has been shown that soft asphalt through having such a high percentage of sulphur can be used in Diesel engines. On no account should engines be allowed to smoke at the exhaust because they will become badly carbonized in a short time.

The crude asphaltic oils are likely to be accompanied by water and solid impurities which do not readily separate from the oils on account of their high specific gravity and viscosity.

The difficulty of viscosity may be overcome by heating the oil before it approaches the atomizer, but heavy asphaltic oils or residues may leave deposits in storage tanks and are sure to give trouble when pumped unless heated. Now it may not be difficult to supply heat to storage tanks on steamers, but a ship having Diesel engines is another matter; truly such a ship may have a donkey boiler or the jacket circulation may be available, but it will lack a good supply of hot steam.

Characteristics of the Hot-Bulb Engine

The hot-bulb engine resembles the Diesel engine in that air only is compressed in the cylinder and the fuel is sprayed in when the compression is complete. The difference is that the compression is not sufficient to produce ignition and there is a hot-bulb or hot plate against which the fuel is sprayed and ignited. The bulb, plate or other device retains enough heat to produce the ignition; when the engine is started, the bulb or plate must be heated by a torch or otherwise. Hot-bulb engines require lighter and more expensive oils than Diesel type engines; they have not as yet been made in so large sizes.

Possibilities of Recovering Oil from Shale

The shales of the British Isles have long been worked for oil and produce an appreciable quantity—about 6 percent of the world's production of petroleum. In America there are mountains of shale, much of which can be worked in open quarries, whereas the British shales are mined like coal. When attention is attracted by new oil fields, especially if they are large gushers, the possibilities even of ranges of mountains of shale leaves one as cold as the mountains themselves. But it is a truism that any business has to carry all its failures. It is necessary to pay for all the dry wells, and even the waste of speculation must be borne by the industry. In mining, a low grade ore easily won and worked is better than scattered pockets, however rich. It is likely that well-financed plants for working shale will deliver a large part of the mineral oil of the country in the near future.

Shale which is a slaty mineral impregnated with petroleum carries only 20 to 25 percent of oil. Since the cost of fuel is mainly that of transportation, no one can afford to burn it except at the beds. It is mined, broken up and distilled in retorts which can be heated by the retorted rock; it is not necessary to use good fuel. The distillates are mostly light hydrocarbons similar to those from petroleum, but there are other valuable products such as ammoniacal liquor. It may even be a question which is the main product and which is the by-product now that nitrogenous fertilizers are so sought after.

The crude shale oil contains so large a portion of light compounds that it is undesirable for Diesel engines; with the present and prospective demand for gasoline, there is no likelihood of any getting on the market. The heavier products are well adapted to both Diesel engines and hot-bulb engines; there is no trouble from asphalts.

Other Sources of Fuel Supply

A very important source of fuel for Diesel and hot-bulb engines is coal tar, large quantities of which are produced every year. There are four kinds of such tar, gas house tar, coke oven tar, black furnace tar and lignite tar. The qualities of the various tars depend on the fuels used and also on the method of production.

Lignite is so inferior as fuel that it may be retorted to make tar, the residue being used as fuel for the retorts. The tar may be burned raw in Diesel, but not in hot-bulb, engines. The distillates contain both paraffin and aromatic compounds, and it is likely that ammonia will prove a valuable by-product. Since the lignite coke has little value, the distillation can be controlled to give the best yield of products. The lighter products are, of course, used as gasoline; the heavier products resemble those from petroleum and can be burned in Diesel and hot-bulb engines.

Gas for illuminating and heating is made by two processes—the old retort process and the so-called water-gas process, by which the carbon in the coal is burned to carbon monoxide. Both processes yield tar and other products, notably ammoniacal liquor. A certain Scottish shipyard uses gas for power and heating; before the war the ammoniacal yield per ton of coal was worth three shillings, the coal cost six shillings—an unexpected combination of agricultural and maritime interests. Tars by this process are not available for engines when raw on account of the high proportion of water and ash.

The old-fashioned horizontal gas retort makes a heavy tar that cannot be used raw in Diesel engines. The newest type of vertical retort as developed in Germany, but now used everywhere, makes a thinner tar that may be used raw. In general, engines must be specially designed to burn crude tar and usually have a higher compression because that material has a high spontaneous temperature of ignition.

The following method of overcoming this difficulty of ignition was proposed in 1916 by Mr. C. Day, and may be in use now. Two fuel pumps are used, one for the crude tar and another for a lighter petroleum or shale oil product, which ignites readily. Since only a small portion of lighter oil is used, it need not be under the control of the governor.

Diesel estimated that there was tar enough in Germany

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to provide power for all industrial purposes and for the navy.

TAR AVAILABLE AS FUEL

It is unlikely, however, that coal tar will be squandered in any such way, because they contain large portions of aromatic compounds from which dyes and explosives are made. The heavier products are well adapted for Diesel engines. Naphthalene, which is a solid, has been used to a considerable extent in Germany when it was cheap enough. Since the use of tar oil began in Germany and was most extensive there, it may be interesting to read the specifications of the German Tar Distillers' Federation:

1. The tar oil must not contain more than 0.2 percent of solids.
2. Water must not exceed 1 percent.
3. Coking residue must not exceed 3 percent.
4. By distillation, at least 60 percent; by volume, must be over 570 degrees F.
5. The calorific value must not be less than 35,000 British thermal units.
6. The flash point must not be lower than 150 degrees F.
7. The oil must be quite liquid at 60 degrees F. When cooled to 47 degrees F. no precipitation must take place after resting half an hour.

The tars from coke ovens resemble those from vertical gas retorts, and some of them may be used for Diesel engines. Mr. H. Moore reported in 1916 that he had run a Diesel engine six months on raw tar from a certain type of coke oven.

Tar collected from blast furnaces contains too much ash to be used in engines; on distillation it yields a small amount of light products and a large amount of paraffin products.

This completes our survey of the field of the present day, for, though peat may yield distillates, there is no present prospect of such use of that fuel, and though vegetable and animal oils readily burn in Diesel engines, they are worth too much for other purposes.

Whatever oil is used in internal combustion engines, it should be bought and sold on specifications and should be tested by experts. Though directions for testing may be published, and though they may appear simple enough to an engineer, he will be ill advised to spend his time on them and cannot be confident of his results. The suggestion might be made that companies dealing in fuel oil will find it good business to submit their fuels on specification and to guarantee them on reports from their experts. The reputations of the companies and their experts will be a sufficient backing, and only large consumers will find it worth while to employ experts on their own account. Though engineers should not undertake any tests of oils however simple, they are entirely competent to understand and use the reports of experts.

Diesel Engine Experimental Work*

BY ENGINEER-COMMANDER C. J. HAWKES, R. N. (RET.)

The object of this paper is to place before the members of the Institution an outline of the experimental work carried out at the Admiralty Engineering Laboratory in connection with internal combustion engines for naval purposes, with special reference to the design and performance of a single-cylinder engine of comparatively large power.

IN 1916, as the result of the representations of the Board of Invention and Research, it was decided to establish an engineering laboratory on a small scale, the work, at first, to be confined to experiments with internal combustion engines. The question of the material and design of pistons of submarine oil engines was referred to the Board of Invention by the Engineer-in-Chief of the Navy and the matter was first considered at a meeting of the Internal Combustion Engines Sub-Committee on November 29, 1915. It was decided to construct a single cylinder oil engine for experimental purposes, utilizing, so far as possible, the parts of a standard submarine engine, in order to save time and also to keep down the cost. The drawings of the piston, connecting rod, bedplate and other parts not of the standard design were made at the Board of Invention and the engine was constructed and erected at the works of Messrs. Ruston & Hornsby, Lincoln. The engine was first run without load on July 17, 1916.

MATERIAL AND DESIGN OF PISTONS OF SUBMARINE OIL ENGINES

Several designs of pistons were considered by the Sub-Committee, including pistons of aluminum alloy in two pieces and also pistons having aluminum alloy heads and suitably lightened bronze or cast iron skirts. Eventually it was decided to commence the experiments with a piston of aluminum alloy, and, in order to keep down the weight of the piston, a comparatively low copper content was decided upon. It was uncertain whether this piston would stand up to its work for any length of time, especially having in view the composition of the aluminum alloy then being recommended for pistons of aircraft engines, but it is interesting to note that the original piston is still in use and it has been run for a considerable time at comparatively high speeds and high mean pressures.

The trunk piston was divided at the gudgeon pin center and the two top-end bearings were carried between its upper and lower portions—the gudgeon pin, to facilitate dismantling, being at first made a driving fit into the eye of the connecting rod. This design followed a suggestion which was put forward some years before in connection with ordinary cast iron pistons, with the object of obtaining a slightly greater gudgeon pin bearing surface. The top-end brasses, which were lined with white metal, were not adjustable. Lubrication was effected by forced feed from the crank shaft through the center of the connecting rod and thence through channels in the hollow gudgeon pin to the bearings. The bearings were held in position by steel end plates. Six cast iron piston rings were fitted in addition to a scraper ring, but, with the object of reducing the possible wear of the piston grooves, the widths of the working faces of the rings were made ¼ inch, as compared with ⅜ inch in the standard cast iron pistons.

The connecting rod was made of 30 to 35 tons steel and was of I-section, the connecting rods of standard submarine engines being of round section. The diameter of the cylinder of this engine (which, for convenience, is known as the "Unit" engine) is 14½ inches, stroke 15 inches, and of 100 nominal brake horsepower at 380 revolutions per minute. Solid injection was first used, but later air injection was fitted for experiments with a modified type of air injection valve.

After the engine had been running at the full nominal

* From a paper read at the summer meetings of the sixty-first session of the Institution of Naval Architects, Liverpool, England, July 8, 1920.

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load for some considerable time it was opened up for examination. It was found that the gudgeon pin was slightly slack in the connecting rod, and it was decided, therefore, to modify the skirt portion of the piston so that it would pass over the foot of the rod for dismantling and thus permit a "shrunk in" gudgeon pin to be fitted.

When these modifications had been carried out the engine was transferred from Lincoln to the Admiralty Engineering Laboratory and the trials were continued in September, 1917. The engine was run at or above 100 brake horsepower at revolutions from 380 to 500 per minute and at mean pressures from 100 to 140 pounds per square inch, and it was not opened out for examination again until July, 1918. It was then found that the piston was in good condition, but the white metal of the gudgeon brasses had worn slightly. It appeared evident that this wear was largely due to the fact that the oil grooves had not been cut in accordance with the instructions on the drawing, and this resulted in reducing the supply of lubricant to the grooves. It was also found that the brasses had hammered very slightly into the aluminum body of the piston and there was evidence that the side clearances between the connecting rod and the brasses were insufficient.

It was decided to bore the eyes of the piston larger, make new brasses of correspondingly greater thickness, with flanges at each end, and to fit more substantial keys to prevent the brasses turning in the piston, as the small keys originally fitted were found to be slack. The experiments have been continued since August, 1918, at mean indicated pressures up to 140 pounds per square inch, but it has not been necessary to make any further modifications to the piston. Whenever the piston has been dismantled it has been found in good condition, and careful gaging has shown that there is no appreciable wear either in the body of the piston or in the grooves, and so far there is no indication of "growth." The cast iron cylinder liner is in excellent condition.

The weights of the aluminum alloy piston and I-section connecting rod of the experimental engine are appreciably less than the weights of the corresponding parts of the standard submarine engine, with the result that the inertia forces in the former at 500 revolutions per minute are approximately the same as in the latter when running at 380 revolutions per minute. The comparative weights of the reciprocating and rotating parts of the experimental cylinder and the standard engines are shown in Table I.

TABLE I.—COMPARISON OF WEIGHTS OF PISTONS AND CONNECTING RODS IN EXPERIMENTAL AND STANDARD SUBMARINE ENGINES

	Experimental Engine	Standard Submarine Engine
Cylinder diameter, inches	14½	14½
Length of stroke	15	15
Revolutions per minute	380	380
Weight of piston, with rings, bushes (in the case of experimental engine), guards, etc., pounds	213	390
Weight of connecting rod, with gudgeon pin and large end bearing and bushes (in the case of standard engine), pounds	290	423
Reciprocating weights (includes two-thirds weight of connecting rod without palm end), pounds	310	560
Rotating weights (includes palm end and one-third weight of connecting rod), pounds	193	253

With the particulars given in Table I the mean pressures on the various bearings throughout the cycle, at 380 revolutions per minute, were obtained for each engine and the results are shown in Table II.

TABLE II.—MEAN TOTAL BEARING PRESSURES THROUGHOUT CYCLE IN POUNDS

Engine	Gudgeon Pin	Crank Pin	Cylinder Liner	Main Bearings
Experimental engine	12,320	16,200	1,420	16,200
Standard engine	15,250	20,260	1,840	20,260

It will be seen, as would be expected, that there is a considerable reduction in the mean total loadings of the bearings due to the use of the aluminum alloy piston and lighter connecting rod, and as the mean rubbing velocities of the various bearings are the same for both engines at 380 revolutions per minute, this reduction is a measure of the increase in the mechanical efficiency of the experimental engine as compared with the mechanical efficiency of the standard engine. This increase in mechanical efficiency would appear to be of the order of 2 percent.

Clearances Between Aluminum Alloy Piston and Liner

The coefficient of linear expansion and the thermal conductivity are greater for aluminum than for cast iron, and in the absence of information so far as large engines were concerned, it was difficult in the design stage to decide on the clearances which should be provided between the aluminum alloy piston and the liner. Eventually it was decided to make the clearances similar to those usual with cast iron in Diesel engines and to note the results. When the engine was first started, and after the engine had been running at a small load for some time, the piston seized. The piston was removed and examined and it was found that it had been in contact with the liner over nearly the whole of its surface and the metal was scored slightly. The piston was therefore "draw filed" and replaced and the engine again put on load. At the higher loads there was a slight seizure and again the body of the piston was filed where it had been bearing hard on the liner. Since that time, although the engine has been running at high speeds, etc., no further seizures have taken place. From the experience gained it may be taken that the clearances required with an aluminum alloy piston should be about 50 percent greater than the clearances necessary with a cast iron piston. Should a cast iron piston seize, it generally results in damaging the liner as well as the piston, but in the case of the aluminum alloy piston it was found that a seizure did not damage the surface of the liner in any way. Further, it was found that as soon as the engine had cooled down slightly after a seizure the aluminum piston was quite free.

There is no doubt, so far as present experience is concerned, that aluminum alloy pistons, although slightly greater in first cost, have many advantages over cast iron pistons. Further experience will shortly be available as to their behavior under actual service conditions, and it will then be possible to decide whether their extended use for submarines is justified. In the meantime other Admiralty experimental engines, including the two-stroke cycle type, have been or are to be fitted with pistons of aluminum alloy for further test.

Capacity of Piston to Withstand Higher Mean Pressures

In view of the results obtained with the "Unit" engine it was decided, when the engine had been transferred from Lincoln to the Admiralty Engineering Laboratory, further to test the capacity of the piston to withstand higher mean pressures by supercharging and also to run at higher speeds. The two methods of supercharging considered were (1) to compress to the supercharging pressures the whole of the air required by the engine by means of a blower or pump, the air passing through the induction valve, or (2) to allow the engine to draw air from the atmosphere through the induction valve in the ordinary way and to add at or about the commencement of compression the additional air for supercharging through ports uncovered by the piston or through an additional valve in or near the cylinder head.

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The alternatives were fully considered, but as the principal object at that time was to test the aluminum alloy piston, it was decided to adopt (1), as it did not involve any structural alterations to the engine. It was consequently arranged to compress to the supercharging pressure the whole of the air required by the engine by means of a standard Roots blower, driven by belt from an electric motor. The blower delivered air under pressure to a reservoir, which was fitted with a combined relief and pressure regulating valve, so that the supercharging air could be adjusted to any pre-determined pressure within the capacity of the blower. A three-way cock was fitted

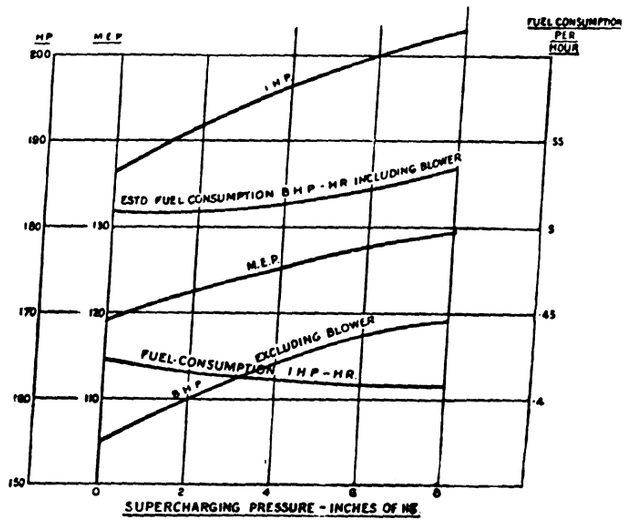

Fig. 1

in the induction pipe so that the engine could take its supply of air either from the atmosphere or from the reservoir. This arrangement gave no trouble, but it was found that the temperature of the air delivered at 3 or 4 pounds pressure after a time rose appreciably and a water jacket was therefore fitted to the blower.

Tests were then carried out with and without supercharging at various speeds up to 500 revolutions per minute, using the maximum quantity of fuel oil delivered by the fuel pump. A six-hole sprayer was necessary at the higher speeds and the pressure in the solid injection system was maintained, as nearly as possible, at 4,000 pounds per square inch by adjusting the fuel valve roller clearance, thus varying both the lift and period of opening of the fuel valve. Further, the compression pressure was 380 pounds per square inch and the average initial, or maximum, pressure was kept at about 630 pounds per square inch by adjusting the timing gear as necessary for each test. The same brand of fuel oil was used throughout, viz., heavy shale oil of specific gravity 0.86 at 60 degrees F. The quantity and rise in temperature of the cooling water to the jacket, cylinder cover and exhaust valve were measured.

During the tests the blower was run at its lowest speed, but the amount of air delivered was in excess of that required at all engine speeds. A calculation had to be made, therefore, based on the curves of output and power furnished by the makers of the blower, in order to obtain the power required to supply the air actually used in the engine. The blower was not very efficient and the calculated power required to supply the supercharging air were known to be in excess of those which would be necessary in practice. The results obtained during the 500 revolutions per minute series of tests which were run with supercharging pressures corresponding to 0, 2, 4, 6 and 8 inches of mercury (as measured by a mercury gage in communication with the reservoir) are shown graphically in Fig. 1. The fuel consumptions per brake horsepower hour inclusive of the blower are estimated. Each trial was of 1½ hours' duration.

Although the powers developed during the tests were limited by the capacity of the fuel pump, the results obtained could not be regarded as satisfactory. The exhaust was not clear during any test and it was evident that it was necessary either to make some alteration to the fuel sprayer or to adopt a different system of fuel injection.

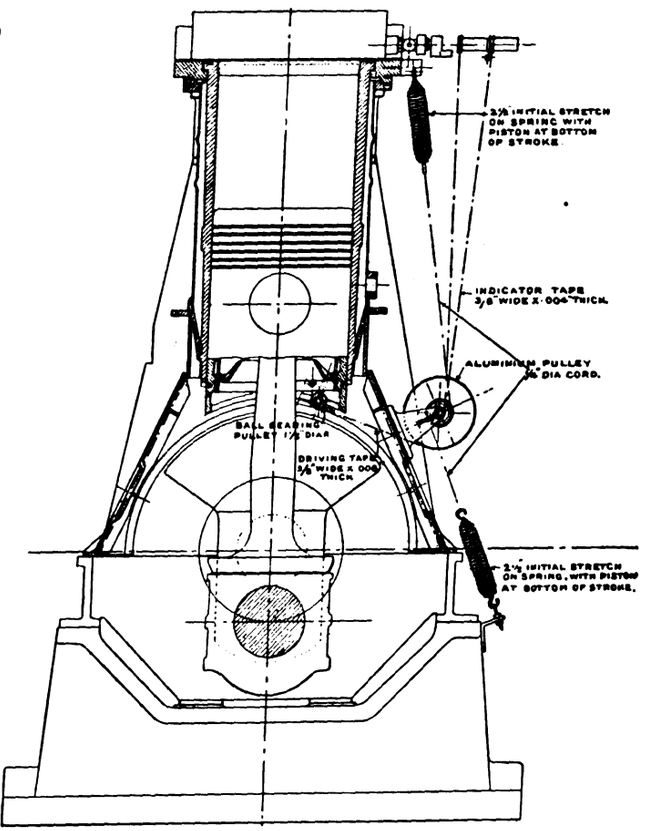

Fig. 2.—Arrangement of Indicator Gear

It was therefore decided that no good purpose would be served by continuing these tests, and it was consequently arranged to experiment with the fuel injection system and to defer the supercharging tests until a later date.

Better results, both as regards power and fuel consumption, would have been obtained by running these tests at higher initial pressures, but it was desirable, at least for the present, to limit the maximum pressure to that usually worked to on service. The results could also have been improved by using a higher fuel pressure in the solid injection system, but, again, it was considered advisable at that stage, and with the fittings then in use, to limit the pressure to 4,000 pounds per square inch. During the later tests diagrams were taken from the fuel system with the object of ascertaining the variation of pressure during the cycle. It was found that with a gage pressure of 4,000 pounds per square inch in the fuel system, with the engine running at 420 revolutions per minute, the maximum pressure was 4,560 pounds and the minimum pressure 3,400 pounds per square inch.

The exhaust pipe outlet to the atmosphere is some considerable distance from the engine, and for convenience it has been arranged to spray water into the first of the

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two silencers fitted and to note the color of the discharge from the silencer drain by passing it over a plate of glass painted white on its under side. It has been found that this method is very sensitive and can always be relied upon to give a true indication of the color of the exhaust. This method has also been used successfully for other experimental engines.

The indicator rig originally fitted to this engine was considered to be unsatisfactory and a new gear was fitted, an arrangement of which is shown in Fig. 2. It will be seen that a steel tape 0.006 inch in thickness has one end connected to the piston and the other end connected to the

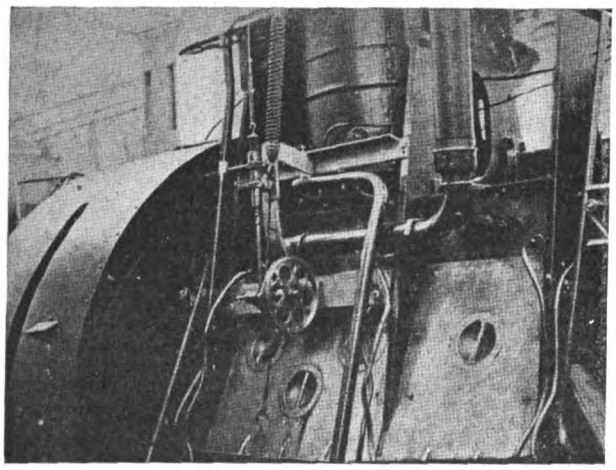

Fig. 3.—Indicator Gear Attached to "Unit" Engine

rim of an aluminum wheel, which is mounted on a small shaft carried in a bracket attached to the engine framing. This tape passes over a ball-bearing pulley 1½ inches diameter. The shaft carrying the aluminum wheel also carries the pulleys to which the tension springs are connected and the pulley from which the indicator tape is taken. By this means a true copy of the movement of the piston can be obtained.

Some difficulties were experienced in connection with the tension springs and the tape fastenings, but by running the whole of the gear in the open by an electric motor, so that all parts were under observation, these difficulties were readily overcome. Various minor alterations were made later, but the principle of the gear has remained the same. A photograph of the gear attached to the "Unit" engine is shown in Fig. 3. Since that time a large number of strands of rubber have been successfully used in place of the tension springs.

Obturator Ring

It may be interesting to mention, in connection with the "Unit" engine, that an obturator ring has been fitted to the piston since August, 1918, and has given fairly satisfactory results. The use of the obturator ring for Diesel engines was brought to notice by Messrs. The Engineering and Arc Lamps, Ltd., of St. Albans, as a number of experiments had already been carried out in an engine at the St. Albans Electric Power Station and very promising results obtained. In the St. Albans engine the first three cast iron piston rings were "pegged in" for the purpose of filling the grooves, an obturator ring of L-section, and about 1.5 millimeters in thickness, was fitted in the fourth groove, and the three remaining worn rings below the obturator ring were retained unaltered. An appreciable clearance was provided between the edge of the obturator ring and the groove in which it was fitted.

The question of the gas pressure behind the obturator ring during the cycle was discussed with the firm's representatives and it was suggested to them that it would perhaps be an advantage to fit a cast iron ring in the top groove of the piston in order to protect the obturator ring from the hot gases. Later, when it was decided to fit an obturator ring to the "Unit" engine for experiment, provision was made for a cast iron protection ring designed to give a radial pressure of about 1 pound per square inch. Further, the clearance between the edge of the obturator ring and its groove was reduced to 0.002 inch, as by this means it was considered that the pressure behind the ring would, by wire-drawing, be reduced to a minimum.

The arrangement of the L-sectioned obturator ring in the "Unit" piston is shown in Fig. 4. The material used is phosphor bronze and the thickness of the ring is 0.05 inch. A lap joint, riveted and silver soldered to one end of the ring, is provided to ensure gas tightness past the gap. A filling ring is fitted, made in halves spigoted together, its width being such that it just allows freedom of movement of the obturator ring.

When the obturator ring was fitted to the "Unit" engine the compression ratio was increased, as it was uncertain whether the ring would be gas-tight when starting up. Later, however, the compression was reduced again to 380 pounds per square inch at 380 revolutions per minute. When the engine was first run with the obturator ring, especially for about 15 minutes after starting, an appreciable quantity of gas passed the piston into the crank case, which would be an objectionable feature so far as its use for submarine engines is concerned, so the ring was removed and eased slightly to give it more freedom. It was clear that only portions of the ring were in contact with the liner and its surface was therefore smoothed up as necessary and eleven slots 1/32 inch deep and 1/16 inch wide were fitted as shown in Fig. 4. At the

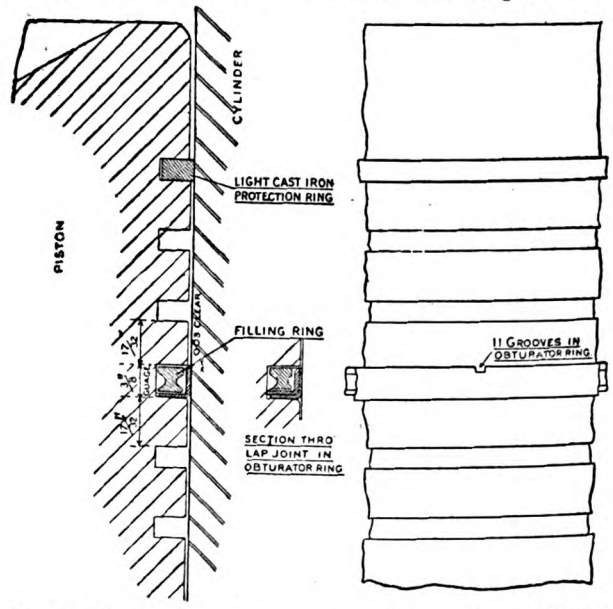

Fig. 4.—Unit Engine. Arrangement of Obturator Rings in Piston

same time the clearance between the edge of the ring and the piston groove was increased from 0.002 inch to 0.003 inch.

These slight modifications resulted in a distinct improvement and the ring worked satisfactorily with mean indicated pressures up to 140 pounds per square inch. No leakage was apparent, although the maximum compression pressure was very slightly less than that previously obtained with the full number of cast iron rings with the

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same compression ratio in use. There was a very decided knock in the piston at the end of the compression stroke, and after running for a total of about 30 hours it was decided to examine the piston and obturator ring. The obturator ring was found to be quite free and bearing generally and there was no measurable wear. The ring was therefore replaced and, in view of the previous knocking of the piston, two additional light cast iron rings were fitted below the obturator ring. These additional rings, which were intended to act as "buffer" rings, practically cured the knocking, but they must add slightly to the piston friction of the engine. It is probable that this knocking could have been avoided by reducing the piston clearance, but nothing could, of course, be done with the existing piston; neither was it desirable in view of running the engine at comparatively high mean pressures.

After running for about 150 hours at various powers, the obturator ring was again measured and the wear appeared to be about 0.001 inch, while the maximum wear in the groove of the piston when gaged was found to be 0.008 inch.

So far the obturator ring is promising, but it has been tested under very favorable conditions, and further experience is necessary before any recommendations could be made in regard to its general use in service engines. The original ring is still fitted in the engine, but there has been no opportunity to ascertain the actual reduction in piston friction resulting from its use. There is no doubt, however, that the engine is more free than formerly and its mechanical efficiency has been slightly increased. It is not known whether any experiments have been made to ascertain whether obturator rings would work satisfactorily when running over ports such as those fitted in two-stroke cycle engines, but it is probable that this will be tried at the laboratory at a later date.

SOLID INJECTION

Very good results have been obtained with the "Unit" engine both with the solid and with the air injection systems. Instructions were received to carry out experiments with the object of reducing the tendency of the standard engines to smoke when using solid injection. A large number of tests were made and eventually smokeless combustion was obtained with the "Unit" engine at all powers from 100 brake horsepower to 25 brake horsepower, and the consumption of fuel oil at 100 brake horsepower and 380 revolutions per minute was just under 0.4 pound per brake horsepower hour. Having in view the fact that the tests were carried out with a single cylinder engine, fitted with a cam shaft driving mechanism designed for a multi-cylinder engine, this figure for consumption is remarkably good. The fuel used was shale oil having a specific gravity of 0.86 at 60 degrees F. During all these tests the fuel oil was very carefully measured, and it may be mentioned that during a six-hours' continuous test the variation in the consumption, recorded half hourly, was under 1 percent. The "Unit" engine is coupled to a standard Heenan & Froude dynamometer for absorbing the power.

Tests were made with the above engine when using air injection, and the fuel consumption at 100 brake horsepower, after making the necessary allowance for the power required to drive the air compressor, was practically the same as the fuel consumption when using solid injection.

Motorship Building in Europe

Six New 14,000-Ton Motor Vessels

BY OUR SPECIAL LONDON CORRESPONDENT

AFTER a long period during which practically no information was given where it could be avoided, the Glen Line is now taking the public into its confidence regarding its big programme in connection with motorships. It will be remembered that Lord Pirrie is chairman of this firm and he is a convinced advocate of the oil engine, being at the same time chairman of Harland and Wolff, the largest motorship building firm in Europe. In addition to the seven 10,000 deadweight ton motor cargo ships

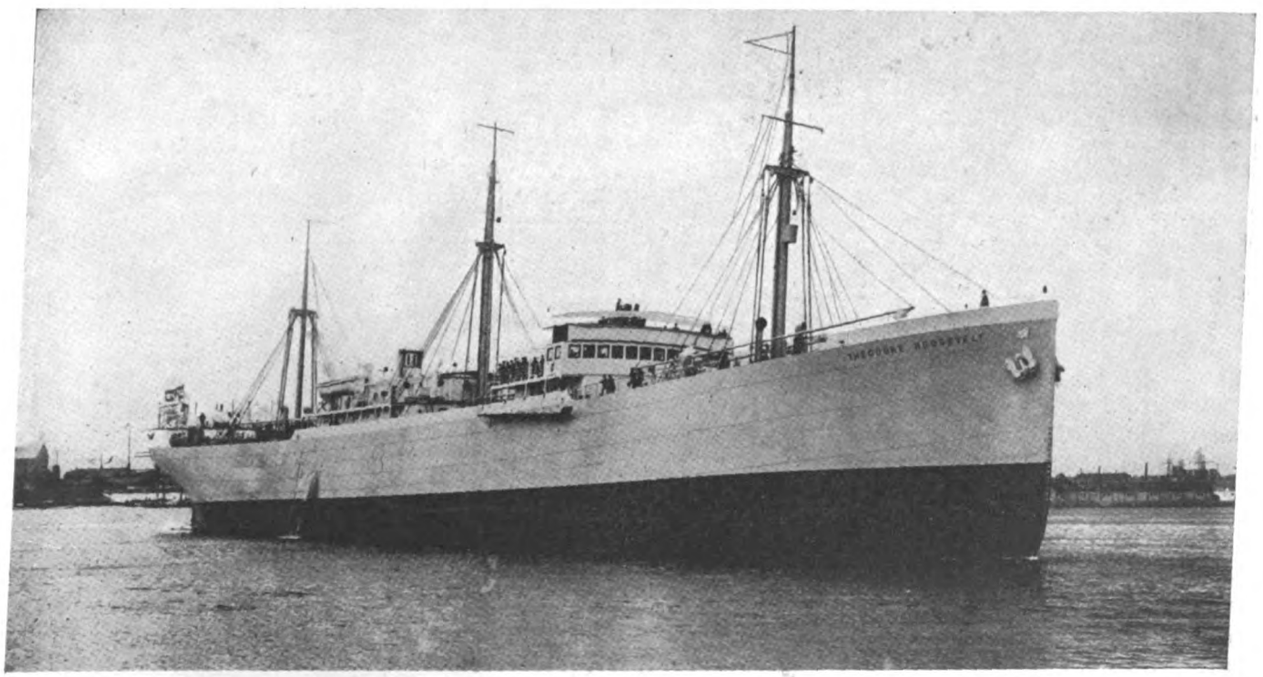

Fig. 1.—The New 9,400-Ton Motorship *Theodore Roosevelt*, Built for the Olsen Line, Christiania, by Burmeister & Wain for Trade Between Scandinavia and the West Coast of America

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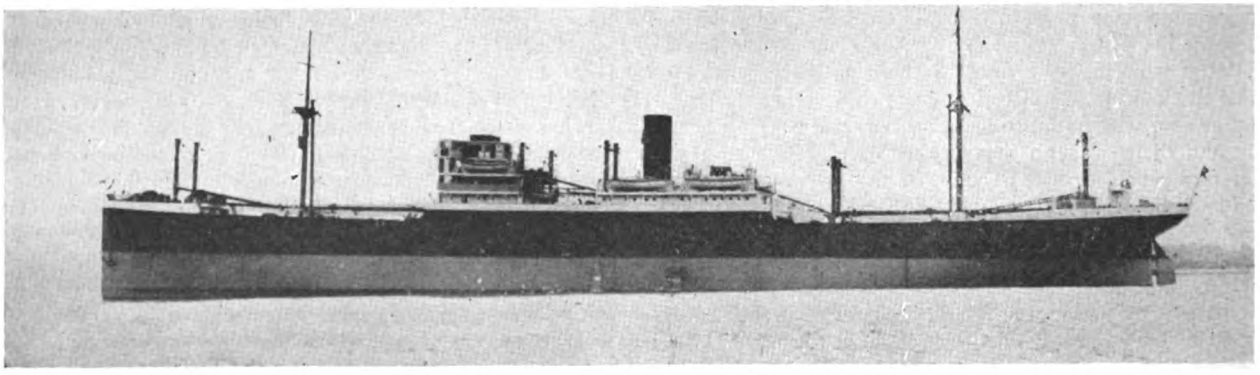

Fig. 2.—The New 14,000-Ton Motorship *Glenogle*, Built for the Glen Line

which are now in service, five more of these craft are to be built, while six 14,000 tonners will complete the immediate programme. The first of these larger ships has just started on her maiden voyage and the remaining five will follow at regular intervals of about six weeks or two months, all being produced from the Glasgow yard where motorship building is so standardized that motorships can be constructed more quickly than steamers and, it is stated, at a price very little in excess of reciprocating engined vessels. In no other way could this be accomplished than by a very advanced degree of standardization, for, as is well known, individual Diesel engine units cost a good deal more than reciprocating steam engines of the same power. The new works of Harland and Wolff at Glasgow are, however, so remarkably well equipped with new and special machinery designed essentially for oil engine construction, that the manufacturing costs are kept down to a manufacturing figure.

Some details of the first Glen Line 14,000-ton motorship have already been given, and it may be recalled that this vessel, the *Glenogle*, is 502 feet in length and is fitted with two of the latest type Harland and Wolff four cycle engines each of 3,200 indicated horsepower. It was found on the preliminary runs that the total fuel consumption including that for all auxiliaries worked out at under 20 tons per day of 24 hours for a speed of 12½ or 13 knots. The engines appear to run with the same ease and reliability as reciprocating steam engines, and the engineers state that there is no more work to do than on a steamer, while the number is much reduced, the engine room staff comprising only seven engineers and three electricians.

It is perhaps doubtful whether the best arrangement has been devised for the auxiliary machinery, which, in this as in nearly all the other motorships being built in Great Britain, is electrically operated throughout. The arrangement adopted is to provide four sets of 100-kilowatt Diesel driven electric generating sets. One of the objects sought is to run these sets at full load, no matter what the power may be, by subdividing them as required. This arrangement works perfectly satisfactorily in the ordinary way, but if every winch is in service for loading or discharging, it may be necessary to run all four dynamos at the same time—obviously an undesirable system. Moreover, the maneuvering compressors, of which there are two, are electrically driven by 180-horsepower motors, so that more

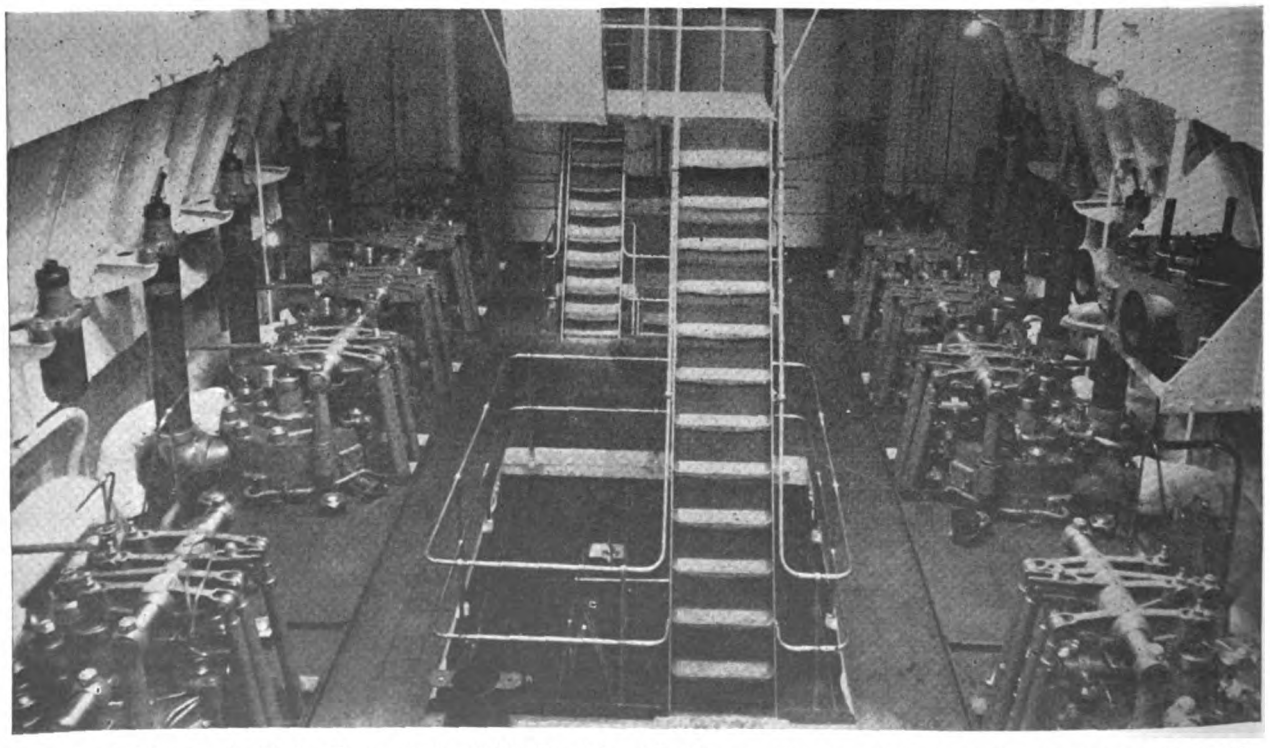

Fig. 3.—A View in the Engine Room of the 14,000-Ton Motorship *Glenogle*, Built by Harland & Wolff, Fitted With Two 3,200-Indicated Horsepower Diesel Engines

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power is required by each of these compressors than can be delivered by any one generator. It may sometimes be necessary to have both these maneuvering compressors running, although one should be sufficient, so that on the whole it is doubtful whether the 400 kilowatts provided for the electrical plant is sufficient. In fact, it is more than probable that another 100-kilowatt set will be installed, but one is inclined to think that a better arrangement could be made by having a smaller number of higher powered units. Manufacturers of oil engines will understand the desire of the builders to maintain the 100-kilowatt set, as they use it not only in the large ships they build, but also in the smaller vessels. They are thus enabled to construct such plants in very large quantities, thus bringing down the cost of manufacture to a considerable extent.

Apart from this feature there appears to be absolutely no fault to find with these standard 14,000-ton ships, and it is worth noting that there is great competition to obtain one of the 12 berths for passengers on the new vessels, for the accommodation provided is infinitely better than is available on most large ocean-going liners.

A Motor Passenger Liner

The second vessel of this class will sail on her maiden voyage early in November and will be named the *Glenapp*. It will be remembered that during the war a motorship built on the Clyde for the East Asiatic Company, named the *Glenapp*, was taken over by the British Government and run by the Glen Line. She was recently returned to the owners, who sold her to the Elder Demster Line, by whom she was renamed the *Aba*. She has been fitted out with accommodation for 200 passengers and will start on her new life in the course of the next few weeks and thus be the first large motor passenger vessel to be put into commission. She will trade between Liverpool and the West Coast of Africa, and as she can maintain a speed at sea of 14 knots and is equipped with machinery of 6,400 indicated horsepower, she will probably be one of the most comfortable and serviceable passenger craft afloat. In addition she will carry a certain amount of cargo.

It will not be long before quite a fleet of motor passenger vessels is in commission, for the *Aba* will be followed in the course of a month or two by the first B. I. motor passenger liner *Magvana*, while the sister ship, the *Melita*, will be completed shortly after, both of these ships trading between London and Calcutta. Then a similar vessel for the Union Steamship Company, of New Zealand, trading between England and New Zealand, will be completed, followed by a large Swedish transatlantic motor liner and several Italian motor passenger ships. In spite of the shipbuilding slump, therefore, the motorship will evidently make great progress within the course of the next few months.

The Doxford Diesel Engine

The first of the 3,000 indicated horsepower Doxford Diesel engines has now been erected and tests will be commenced almost immediately, after which the engine will be installed in a 10,500-ton single screw cargo ship for Messrs. B. and J. Sutherland and Company, of Newcastle-on-Tyne.

In addition to the four engines of this type which Doxfords are building at Sunderland two more of exactly the same size are under construction in Sweden for Swedish shipowners who appear to be much taken with the Doxford design, since the Transatlantic Company of Stockholm has already ordered one motorship to be built in England fitted with a Doxford engine. The results of the tests of the first engine are awaited with the greatest interest by engineers, shipowners and shipbuilders, on account of the novel features in the design of the motor, which include solid fuel injection at a pressure of about 7,000 pounds per square inch, a compression pressure of only about 300 pounds per square inch (against 480 pounds with the usual Diesel motor) and the adoption of the opposed piston principle for the first time on a really large engine.

There are only four cylinders 580 millimeters diameter and 1,160 millimeters combined stroke, and in order that the compression pressure may be kept at a low figure, there is a special solid heat retaining top to the piston which is not water cooled like the remainder of the piston. The heat thus retained combined with the heat due to the compression of the air is sufficient to ignite the fuel even though the compression has not risen above 300 pounds per square inch. It is, however, necessary to heat the pistons before starting up, this being done by passing hot water through them for about half an hour before commencing the run. There does not, however, appear to be any saving in weight in this motor, for the 3,000 indicated horsepower set running at 77 revolutions per minute weighs well over 300 tons.

15,000-Ton Italian Motorship

The tendency towards the construction of larger ships is to be noted throughout the whole of Europe, and in addition to the 14,000-ton ships for the Glen Line, similar vessels are being built for the East Asiatic Company, while in Italy, besides the standard 8,100-ton class of motorship of which several examples have now been built and several more are on order, the Ansaldo San Giorgio Company has contracted for a 15,000-ton cargo ship fitted with 4,000 brake horsepower machinery. This vessel will be 511 feet 5 inches in length with a beam of 65 feet 6 inches and a load draft of 25 feet 11 inches. She will have a speed of 11½ knots and be equipped with two 2,000 brake horsepower six cylinder Ansaldo two cycle motors of the same type as those installed in the various Ansaldo engined vessels now trading between Italy and America. Their chief peculiarity lies in the adoption of controlled port scavenging, while another feature of interest is the interposition of a flexible distance piece between the cylinder cover and cylinder top, by which it is claimed that any possibilities of cracks are eliminated.

Motor Boat Show to Be Held in December

At a recent meeting of the show committee of the National Association of Engine and Boat Manufacturers in New York, spaces were allotted for the sixteenth annual motor boat show to be held in Grand Central Palace, New York, December 10 to December 18. Leading engine and boat manufacturers were represented and the applications for space were so great that it is evident the record-breaking February, 1920, show will be repeated if not surpassed.

In February the exhibits totaled more than 100, and a good percentage of these showed boats of the pleasure and cruising type. This year there will be a much greater display of boats, both from manufacturers in this country and in Canada.

Stock model cruisers from as far west as Wisconsin will be on exhibition, and there will be a special display of speed boats, including several built to defend the recently captured Harmsworth Trophy.

Reports from authorities in the oil industry on the Pacific coast indicate that a fleet of tankers twice the size of the present fleet now on the Pacific will be needed during the next two years to meet the requirements for handling oil.

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Reciprocating Engine Crosshead Design Applied to Heavy Oil Engines

BY W. D. FORBES

This series of articles on the design of reciprocating parts for heavy oil engines, of which the following discussion of the crosshead forms a part, is based on the author's extensive experience in the design and construction of high-speed auxiliary marine engines. Data on the power transmitting elements of the Diesel mechanism as opposed to the static units, such as the frame and crank case, are rather meager, so that where a similarity exists between such parts and those of the reciprocating steam engine, the same principles may well be applied to oil engine construction.

IF Sir James McKechnie's prophecy as to the position the heavy oil engine will hold in marine propulsion of the future is true, the study of the design of parts used in reciprocating engines may very well prove useful in the construction of similar parts in the oil engine. Because there is a certain relation between the various parts of reciprocating steam and reciprocating oil engines, I propose to discuss the various parts of the motor or engine which directly transmit the power in contra-distinction to the static pieces. The power delivering parts are the piston rod, crosshead complete, connecting rod complete and the crank shaft, while the static parts include the frame, crank case, cylinders and the like.

Crosshead Design

The first part to be considered is the crosshead, which, together with the piston and rod, has a right line motion as opposed to the crank shaft, which has a rotary motion, and the connecting rod, which at one end has a swinging as well as a right line motion and at the other a swinging and rotating motion combined.

The crosshead is the flexible point of connection which permits the right line motion to develop into the final rotary motion of the crank shaft. The first problem in the design of the crosshead is to determine whether the crosshead pin shall be supported at both ends and a single pair of brasses used or whether it shall be of the overhung type utilizing two pairs of brasses. In this case more metal is required to obtain a strength equal to that of a design which has a pin supported at only one end. Every designer well knows the usual form of overhung pin and the "spade handle" type connecting rod which accompanies it, as well as the nicety of adjustment which the twin brasses require. The overhung design of pin also requires four sets of liners together with bolts, lock nuts and cotterpins. In order that the four parts which make up the brasses shall wear alike, great care must be exercised in obtaining uniform material so that each bearing will last for the maximum period of service. The best practice is to cast twin bearings of the overhung pin type in the same heat, because in so doing a similarity of metals is assured.

Two Methods of Designing Pins of the Overhung Type

Overhung type pins may be produced in one of two ways: they may be turned on the crosshead pins, making the pin solid, or they may be turned separately and fitted to the crosshead, leaving the ends overhanging. The latter method, of course, demands a carefully drilled hole and a pin which may be turned to either a forced, shrunk or tight fit, which will permit the pin to be easily removed for renewal. If the pins are forged as parts of the crosshead they do not lend themselves readily to the hardening process, although it is possible to both harden and grind such a piece. Should the pins crack or break, however, the cost of reproducing the design is great and the loss in time serious, so that it is not the best method of constructing the crosshead.

If the pins are forged solid, the piston rod can be made to pass through the piece, which is a distinct advantage, as it allows the rod to be adjusted in line with the cylinder, or, if no adjustment is wanted, a taper connection can be made between the rod and the crosshead. If the pin is inserted, this through-hole for the piston rod is not as satisfactory, since the body of the pin must be enlarged to permit the passage of the rod through it without weakening it. Such a design, however, furnishes a solid anchorage for the pin. In speaking of the crosshead piece, it is intended that this part of the design shall not only carry the pin or pins, but also provide an extension to form the support of the shoes as well as provide the connection for the piston rod.

The cost of this design is excessive, and if the engine in which it is to be used is large, the grinding of the solid pins requires a large grinder to do the work, while, on the other hand, the inserted pins may be turned out on a smaller machine. Where the inserted pin is used, whether it is shrunk in place or a forced fit, there must be provided some means of preventing its turning should the brasses tighten on the pins. As the inserted pin has the advantage of being easily replaced, whatever means is taken to prevent the pin turning it should be such as to retain this advantage if it becomes necessary to insert a spare pin. The best method of obtaining this result is by fitting a key or, more properly, a feather to the crosshead piece, the keyway being in the pin. There is little tendency for the pin to work out of the crosshead, but to prevent any chance of this, a small set screw is fitted to it.

Drawbacks of the Overhung Pin Design

The objection to the overhung pin lies in the fact that there are two bearings which must be provided with oiling tubes and the like. Should the supply of oil fail in either bearing, serious breakdowns might result. There is double the chance of trouble with overhung pins for this reason. It is usual to provide a generous fillet where the pins join the main piece of the crosshead. Although this fillet provides increased strength and prevents cracking in hardening, it takes a certain amount of bearing surface from the pin. The brasses must be turned out to allow for the fillet quite liberally. To overcome this loss of surface, however, a right and left hook tool with a round nose should be used when turning up the pins, in order to undercut into the main piece of the crosshead, making a blind fillet, so that the sections of the pins which extend beyond the faces of the piece are entirely free from the fillet. The full length of each pin thus is made a bearing

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esign

surface for the brasses. This system provides a greater overhang than if an outside fillet is used, and this fact must be borne in mind in deciding the diameter of the pin. If the pin is of the inserted type, the blind fillet is obtained by making the enlarged part enough shorter in the body to keep the fillets back of the faces of the main piece of the crosshead.

METHOD OF CONSTRUCTING THE MAIN PIECE OF THE CROSSHEAD

In selecting the material of which the main piece of the crosshead is made, either steel castings or forgings may be considered. If the former is used, it will be found that the design is heavier than the forged crosshead. A casting, however, is much cheaper and quite reliable, although there is always the chance of flaws developing under the stress of service conditions, while forged parts present no such danger. For the grade of work required in marine Diesel engines, forgings are always advisable even at a greatly increased cost. The crosshead with a support for the pin must be made of two pieces if forgings are decided upon. If the entire crosshead is forged, it can be made lighter, although the cost in this case is increased over that of the built-up type. Whether the crosshead is forged or cast, the pin may be made in several ways—a straight pin forced or shrunk in place, a straight pin fitted to two supports and held in place by nuts on each end of the pin, or a straight pin with a head on one end and threaded on the other for a lock nut. In the latter case the threaded end may be reduced in diameter. The forced or shrunk-in pin has certain drawbacks that should prevent its choice, but if it is used the bearings at the ends should be wide and the holes in them should be of two different diameters so that they will not be distorted when the pin is forced into place. A small set screw should also be provided to prevent the possibility of having the pin work out. The advantage of having the pin held in place by a lock nut lies in the ease with which it may be replaced.

Only one short key can be used with the removable pin, and that must be made fast to the crosshead piece, the keyway being in the end of the pin. When a single pin is used, supported at both ends, it is evident that the upper end of the connecting rod can no longer be of the forked type, but must be what is often called a solid end. However, the construction of the connecting rod will not be discussed at this time except in so far as it is necessary to explain the construction of the crosshead.

ALLOWING FOR THE SWING OF THE CONNECTING ROD

In order to have the ends of the connecting rod swing, the space between the two supports must be cut away. In the case of a casting, this is easily done by coring, while in a forging it must be machined away, which is a difficult operation and requires specially arranged machines. It is not necessary to work with a great degree of accuracy, although the two inner faces of the pin support must be parallel and smooth; the rest of the space is clearance. The method of connecting the piston rod to either the cast or the forged crosshead has been previously discussed, but it may be well to add that when a casting is used it is customary to tap into the metal for the piston rod, which is then threaded. Care must be taken in boring or tapping the hole to have the piston at right angles to the crosshead. The face of the head must also be carefully alined to the center of the piston rod. The latter may be corrected by filing or scraping if it is out of alinement, but if the piston rod and pin are not set at right angles, nothing can be done to correct the error and still preserve the measurements of the original design. In such a case the only way in which the defect might be overcome is to re-bore the crosshead pin holes.

To insure correct alinement of the piston rod, it is common practice to first bore or thread the holes for the rod in the pin, and, by screwing or fastening the rod in place, obtain the desired result by laying the rod in V-blocks on the platen of a boring mill, making sure, of course, that the V-blocks are adjusted at right angles to the boring bar.

CONSTRUCTION OF THE FOOT OF THE CROSSHEAD

In designing the foot of the crosshead, ample surface must be provided, especially in the direction of greatest wear, to preserve the surface in the best condition. A broad horizontal foot which is narrow vertically is not as good as the reverse. It is a well-known fact that a short surface reciprocating on a long one results in the shorter surface wearing convex and the long one concave. It is evident, therefore, that the crosshead shoe should be made as long as possible vertically in order to overcome this tendency, bearing in mind, however, that if the shoe is long it must be supported over its entire length to gain an advantage.

To my mind, it is poor engineering if a piece is added to a moving part when it may be equally well put on a static part, and this idea should be carried out in crosshead design. For example, the crosshead shoe should never be placed on the moving crosshead, as it may better be fitted to the face of the guide. In this construction there is a distinct advantage of lightness in the moving parts and also in decreasing the number of these parts.

SPADE HANDLE TYPE CONNECTING ROD

In the designs which have been discussed, the pins have been an integral part of the crosshead, and we shall now take up the discussion of a design in which the pin is not a part of the main piece, but is, in fact, a part of the connecting rod.

The term "spade handle" has been used previously to describe the form of connecting rod having a forked upper end. The two forks of the rod in this case are connected by a pin firmly secured by shrinking, forcing or fitting it in place. It is also possible to make this pin solid; that is, to turn it up in the same way as are the pins in the crossheads of a locomotive. Special machinery is required to do this quickly, and the design is rarely, if ever, found in marine work. If the pin is solid, it is impossible of renewal, and when worn a new rod will have to be supplied.

It is difficult to renew shrunk or forced pins, so that it is preferable to use a fitted pin.

MODIFICATIONS OF FORGED CROSSHEAD DESIGN

At this point is may be well to take up the modifications in the design of a forged crosshead in order to use a pin with a single bearing fitted to the connecting rod. In this instance either of two designs may be used; the first is one in which a box-shaped opening is machined out in the crosshead main piece to receive the pair of brasses which are passed into the opening from the sides. In order to assemble this design, the pin is passed through the brasses. The second method is to provide a front or bottom opening to the recess for the brasses which is closed by a piece of metal held in position by screws or bolts. The latter construction allows the brasses to be passed around the fixed pin in the connecting rod, and with this type pin this is the only design permissible. The opening may be made at the lower end of the crosshead piece or at right angles to it on the front. The latter position has certain advantages. If the opening is made

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at the bottom of the crosshead piece, bolts cannot be used, so that studs must be resorted to, and it is difficult to provide enough strength in these to take care of the strain which is put on them. Then, too, the sweep in the fork of the rod must be great enough to clear these studs, and the resulting cutting away of the metal is open to objection. If, now, the face of the crosshead piece is cut away to admit the brasses to be placed in position, the closing piece can be made with two or more ribs which fit into recesses in the crosshead, and very light studs only are necessary to hold it in position while at the same time providing sufficient strength. In any case, there are parts used which are liable to work loose and give trouble, and an engine should never be fitted with them when they may be eliminated.

When the box-shaped opening is cut out of the solid crosshead piece there is nothing to work loose and greater strength and compactness may be obtained than by the use of the open front or end system. This design should be adopted in spite of the fact that it is a little more difficult to make. The "eye," as it may be called, must be scraped to a sizing block in order to be sure that spare brasses will fit when installed.

Taking Up Wear in the Bearings

It is, of course, necessary to provide some means of taking up wear in the crosshead brasses in either system, and the wedge employed is usually ample to accomplish this. The common practice is to bevel the upper half of the brass to meet the wedge which is forced in by means of set screws tapped into the crosshead. Some means also must be provided to draw the wedge back in case of necessity, which is best done by having a shoulder screw passed through the crosshead piece and tapped into the wedge at the centerline. The forcing-in screws are placed at the ends of the wedge.

In order to hold the top and bottom brasses firmly in place, a single pair of brasses is often made with shoulders which fit over the main piece of the crosshead. At times these brasses are made without shoulders, for the wedge in the upper brass has a path machined for it, and, since the withdrawing shoulder screw passes through the crosshead and into the wedge, the brass cannot move sidewise. To hold the lower brass in position in this case, a pin is set into the bottom of the piece and a hole drilled to register with it in the lower brass. If the fitting has been properly done, however, there is little chance for side motion in the brasses, as the inside sections of the connecting rod forks prevent any displacement. Since the brasses extend a little beyond the crosshead piece, however, it is just as well to secure the brasses as described in order to have the connecting rod bear on the brasses, especially if an improper alinement gives a tendency for the brasses to shift.

Fitting the Shoe to the Crosshead

The general form of the crosshead piece in relation to the shoe, as previously described, is a flat surface as long as possible with sufficient width to provide an adequate wearing surface. To join this flat surface with the main piece of the crosshead, a web is made which should be extended to the top and bottom edge of the foot in order to support it firmly. This web may be made quite thin, since all the strength required is to overcome the compressive action of the piston rod and connecting rod thrust.

It is quite posible to forge the piston rod and crosshead together, and this design provides the greatest strength and lightness. It has, however, the disadvantage of requiring a complete new forging in case the rod is bent or worn badly. In spite of this fact, the solid design is so simple, light and strong that despite the disadvantage of expense I believe it to be the best possible construction.

Service Requirements of the Oil Engine

In the oil engine the danger of bending the piston rod is less than in the steam engine, as it it not possible to trap a solid body of condensed steam between the cylinder heads and the piston, since there is no steam to condense and the clearances are much greater. Wear is, of course, equally possible, and I believe that a piston rod fitted with a sleeve which can readily be removed would provide a design which would work well in combination with the solid forged piston rod and crosshead. This design has proved very satisfactory in steam engine practice.

I do not at all agree with the statement that the workmanship in the oil engine must be vastly superior to that required in steam engine construction. It is true, of course, that where high pressures are utilized the joints must be made with greater care than where lower pressures are to be resisted, and for this reason oil engine joints must be of a higher grade than those of the steam engine. In the parts which have been described, however, the construction is sufficiently good for any oil engine. In the fit of the piston and its rings, better work has to be done in oil engine practice on account of the greater pressures, as well as on account of the higher temperatures encountered. The power developed in any engine must govern the bearing surfaces, and if these are provided for there is no reason why the parts not subjected to the great heat and pressures should be better made than those provided in the steam engine.

Programme of Naval Architects' Meeting

THE twenty-eighth general meeting of the Society of Naval Architects and Marine Engineers will be held in the Engineering Societies Building, 29 West 39th street, New York City, November 11 and 12, 1920. At the professional sessions, which will begin at 10 A. M. each day, the following papers will be read and discussed:

THURSDAY, NOVEMBER 11

"University Education in Ship Construction and Marine Transportation." By Professor Lawrence B. Chapman.

"Launching of Ships in Restricted Waters." By Lieutenant-Commander Harold E. Saunders, C.C., U. S. N.

"New 20,000-Ton Tankers." By Harold F. Norton.

"Economical Cargo Ships." By Alfred J. C. Robertson.

"Notes on Rivets and Spacing of Rivets." By Hugo P. Frear.

FRIDAY, NOVEMBER 12

"Comparative Tests of Bilge Keels and a Gyro-Stabilizer on Model of the U. S. Aircraft Carrier *Langley*." By Commander William McEntee, C.C., U. S. N.

"Surface Condensers." By Luther D. Lovekin.

"Rules and Regulations for Freeboard." By David Arnott

"Recent Advance in Oil Burning." By Ernest H. Peabody.

"The Problem of the Hull and Its Screw Propeller." By Rear Admiral Charles W. Dyson, U. S. N.

The annual banquet will be held at the Waldorf-Astoria Hotel, New York, on Friday evening, November 12. Arrangements have also been made for an inspection trip on Saturday morning, November 13, to the yard of the Federal Shipbuilding Company, at Kearney, N. J.

The council of the society will meet at 3 P. M. Wednesday, November 10, in the Engineering Societies Building, 29 West 39th street, New York, and applications for membership should reach the secretary in time for proper consideration before this meeting. The question of increased entrance fees and annual dues will be considered at the forthcoming meeting of the society.

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Some Notes on Cargo Handling

BY LAWRENCE B. CHAPMAN

In attempting to find a solution for the inefficiencies in cargo handling at marine terminals which tend to handicap this country in the ocean carrying trade, the author has made a careful survey of conditions at one of the principal American ports. Since the methods practiced here are quite typical of other ports, the following suggestions based on these observations will be found of value in determining the means that must be taken to improve terminal efficiency in general.

THE next few years are bound to be trying ones to the American merchant marine; mistakes are going to be made due to inexperience, competition is going to be keen from nations more experienced and better established on the sea than we are, and various unfavorable conditions under which our ships operate will have to be overcome.

Brokerage, management and port charges are pretty well fixed and little reduction can be made here. Fuel for a slow speed cargo ship is rather a small item, ranging from 10 to 20 percent of the annual expenses, depending on the number of voyages per year and the prevailing price of fuel. In a later article I shall consider at length the subject of fuel economy. With the rising price of fuel it is becoming a more important item than formerly.

The two large items of the annual operating expenses are capital charges, which include interest, depreciation, amortization, insurance, repairs and overhauling; and the cost of loading and discharging the cargo.

Speeding Up the Loading and Unloading of Ships

If we grant for the time being that our first costs are higher than our competitors' (which certainly will not be the case long) and that the freight rates are the same, obviously the only way for us to exist is, first, to increase the earnings by more "turn arounds" per year and then to reduce the cost of handling cargo. It is to these two features that I wish now to direct attention. The time of detention in port and the cost per ton of loading or discharging a cargo are closely connected. Any method used to speed up the handling of a ship's cargo accomplishes two results: it reduces the cost of loading and discharging and shortens the term of detention in port. Detention is by far the more important of the two, for it reduces the ship's earning capacity.

It is obvious to even the casual observer that the present methods of loading, discharging and handling cargoes in American ports are in many cases hopelessly inefficient and out of date; in some instances the methods used are the same that existed fifty years ago. It is true that labor conditions are at present almost out of control, and strikes followed by congestion in the ports and on the piers have been of frequent occurrence; yet with all these disadvantages the possibilities of improvement are prodigious.

Estimating the Rate of Handling Cargoes

By estimating the weights of the various drafts and timing the number of drafts per hour, I found that the rate of discharging and loading for the various piers of the port at which observations were taken varied between 14 and 34 tons per hatch per hour, with one striking exception where the rate was 70 tons per hatch per hour. In many cases only portions of the hatches were being worked at one time.

The following methods of handling were used: (1) The swinging boom where only one hoist was in operation. In many cases this hoist was used in combination with a skidway which extended from the pier to the ship's deck. The hoist hauled the draft up the skid and then lowered it into the ship's hold. This gangplank skid was always used where the space between the ship and transit shed was narrow and could be employed to good advantage in such cases. (2) The "yard arm" system where two hoists were fast to each draft, one hoisting from the pier and then slacking, while the second took up the strain and lowered into the hold. (3) Burtoning the cargo, i. e., one boom hoisting from the hold and landing on deck and a hoist on a second boom hooking on and lowering to the pier while the first returned for a new draft. In every case the burtoning system was the fastest, and it is the only one that should exist, except in the special cases enumerated below.

Delays in Discharging

The most serious delay was at the discharging end of each draft—in the hold in the case of loading and on the pier in the case of discharging. In discharging, the delay was largely due to the small area available on the pier for landing the draft. Frequently the draft was held suspended until the pier gang had removed the previous draft, as the narrow space between the ship and the transit shed only allowed sufficient room to place one draft at a time. A constant delay was occasioned by the two pier men waiting to catch the draft and then place it in a position favorable for loading to the hand trucks.

In loading, a long time was lost by the gang in the hold attempting to place the draft in the most advantageous position for stowage, or in waiting for a gang to be free to take charge of the incoming draft. Frequently in loading there was a long wait on the pier end for the shed gang to bring up freight. In one case there was just sufficient space for one load to be prepared at one time, and, as the burton system was being used, the shore hoist was always waiting for a load to be prepared and the hold hoist was waiting for a draft from the shore hoist.

In very few cases was there any attempt made to use the "reservoir principle"; that is, to have several loads at each place at the same time in order to keep the system in operation in case of local delays. Thus there was only one draft on the pier at one time available for the pier truckmen on the ship's hoist, and only one draft on deck available for the second hoist when burtoning, either to the hold or to the pier. The lack of these "reservoirs" caused frequent and needless delays. In nearly all cases there were two gangs of four men in the hold, two men on deck, two men on the pier, two winch men and nine to twelve truckers per hatch.

Possibilities of Efficient Methods

The case where 70 tons per hatch per hour were being handled deserves special mention, for the methods used were in sharp contrast to all the others; yet here only three out of four hatches were being worked at the same time, which shows that reduction in cargo handling expense was the object of the more efficient methods and not the

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reduced time of holding the ship in port between voyages.

In this case a cargo of uniform packages was being unloaded. The burtoning system was used, and there was no delay either in the hold, on deck or on the pier. Each draft from the hold was landed on deck, where there was space for several at one time, and the hold hoist immediately returned for a new draft. On the pier there was a raised platform opposite each hatch with space for two drafts on each, the ship's outboard hoist delivering alternately to the forward and aft ends of the platform. Electric trucks capable of carrying two drafts from the ship's falls removed the cargo from these platforms. At times the ship's hoist was discharging at a rate of three drafts per minute and sometimes even faster; yet there were no delays and the electric trucks removed the cargo to the shed as fast as it was discharged.

SUGGESTIONS FOR IMPROVING PRESENT CONDITIONS

I offer below some criticism of the present methods and suggestions for decreasing cargo handling costs and reducing the detention of ships in port. Some of these are not new, as they have been proposed by our terminal engineers; nevertheless little attempt is being made to introduce even the suggestions already proposed.

The burtoning system of handling cargo, where one boom hoists from the hold and transfers the draft to a hoist on a second boom, which lowers it to the pier, is by far the fastest and most efficient. In special cases when working a cargo with a cargo mast on the pier, either to the first or second deck of pier, the "yard arm" system may be preferable.

The space between the transit shed and the ship should be wider than in many existing cases to give ample space for a "reservoir" so that there never will be a case where the truckman on the pier has to wait for a draft from the ship's hoist, or the ship's hoist has to wait for the truckmen to bring up a load. This wide space also allows room for a rough sorting of the cargo.

In many cases, especially with a uniform cargo as baled or bagged goods, or uniform boxes and the like, a raised platform on the pier is of great advantage for loading onto the pier trucks. In no case should time be wasted in swinging each draft into an advantageous position for loading on the hand trucks.

A "reservoir" station should be maintained on deck so that one fall will never have to wait for the other.

There is too long a delay in the hold in stowing cargo and locating exact position to land each draft. More men should be employed in stowing.

Wider and either longer hatches or hatches closer together should be fitted to obviate delay in stowing and unloading cargo under deck at the sides and ends of hatches.

Either two hatches with a boom serving each or a long hatch with a boom serving each end should be fitted to each cargo hold. A 14,000-ton deadweight ship would have eight hatches, and, if possible, ten or twelve booms serving these hatches at one time. With the burtoning system this would mean twenty to twenty-four booms and winches in operation at one time. This of course is the upper limit for a ship of this size (about 500 feet in length). It will be impossible to operate two hoists in one hatch at the same speed as one, unless the hatch is a long one, on account of interference and danger to the men in the hold.

Whenever possible, a pier should be constructed so that barges and lighters can lay along the side of the ship away from the pier and receive or deliver cargo for waterfront deliverance or for transportation by inland waterways. In this way double handling for such cargo is avoided and increased speed of handling is brought about without undue congestion in the transit shed.

NECESSITY OF INSTALLING ELECTRIC AUXILIARIES

The extremely inefficient steam winch should be done away with and electric winches installed in their place. The current for these winches can be supplied either by shore current or a small Diesel electric set. This will greatly reduce the cargo handling cost and allow the fires to be drawn in all the boilers (except when needed for heating). This will have the further advantage of leaving the engine room force free, and as none of the steam power plant is in operation, overhauling can be easily carried out. There is no doubt that the steam steering gear and the steam deck winch are the two most inefficient pieces of apparatus on shipboard.

Electric trucks either with or without trailers should supersede the hand truck.

The transit shed should be equipped with overhead traveling cranes, monorail crane equipment, tiering machines, etc., for handling and assorting the cargo.

Railroad tracks with connections to the main track lines should lead to every pier or, better, the space between the transit shed and the ship. Trucks and teams should not be allowed within the transit shed except in a central driveway. With this layout the shed crane system can receive and deliver all freight to or from the cars or trucks, and the space within the transit shed is free for sorting and tiering of the cargo.

Many of the piers today are equipped with absolutely no crane service and the methods used in handling heavy pieces of freight are no different than those used in the days of the clipper ships.

Standard containers should be used to obviate the rehandling of small package freight and thus reduce the cost of handling all along the line.

"Stream unloading," as formerly used at Hamburg, should be given consideration in all new layouts. Wherever possible, all goods for waterfront delivery should be loaded directly onto lighters, and all goods for delivery by inland waterways should be loaded into barges alongside.

Two-deck transit sheds have many advantages—one deck for incoming and the other for outgoing cargo.

There are still many people who for various reasons doubt whether we can compete successfully at sea with other nations. The reasons generally given for doubt are the higher first cost of our ships and the higher wages paid American crews. The bogy of crew expense always seems cropping out. A study of the operating costs of American ships shows that the wages and subsistence of the crew range around 10 percent of the total annual operating expense. Surely this is not the place to direct our efforts in cutting down expenses or to waste time worrying about competition. It is time that the public realized what a small percentage of the operating expense the crew actually is. A ship of 12,000 tons deadweight costs in the neighborhood of $2,000,000 and has a crew of between 50 and 60 men. When one stops to compare the number of men employed by an industrial plant on shore costing $2,000,000, it is realized perhaps more clearly that the labor cost on shipboard is, after all, a small item.—LAWRENCE B. CHAPMAN.

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NEW PIERS FITTED WITH GANTRY CRANES

Traveling gantry jib cranes should be fitted on all new piers. These are especially useful for heavy pieces of freight. When the cargo consists of small miscellaneous freight these pier cranes can work in conjunction with the ship's booms, one swing of the crane to two or more drafts of the ship's falls. In loading, the pier crane can swing the draft directly from the pier into the ship's hold, leaving the ship's booms to swing into stowage. For small package freight where, on account of bulk, the draft is limited to the neighborhood of 1,200 pounds, two ship's booms served by electric winches would appear to be better than the pier crane. When the railroad track is on the outside of the transit shed, the traveling gantry is indispensable for loading and unloading cars. It is also useful in transferring goods into and out of the transit shed and for receiving and delivering freight for inland water transportation when a ship is not at the pier.

A scheme has recently been proposed that has some possibilities. It consists of cranes on dolphins outside of the ship. These cranes can deliver or receive either to the pier or to barges or lighters alongside the ship.

There should be a "getting together" of steamship companies, pier authorities and transportation interests for the quicker and more efficient handling of ship's cargoes.

TRUCK CONGESTION ON THE PIER

Obviously all methods to reduce detention are of no avail if a ship has to wait for a cargo or sail with a partial cargo. At one pier that came under my observation a large part of the freight for a ship's cargo was apparently being delivered by trucks in one day, resulting in a most hopeless congestion of trucks on the pier and in the street, to say nothing of long and expensive waiting of the trucks for an opportunity to deliver freight.

Everything should be done to improve the conditions of the longshoremen so as to speed up their work. Some sort of bonus system or piece work system should be introduced not alone to decrease handling costs but more especially to decrease detention in port.

Probably the best all around draft is around 1,200 pounds; loads larger than this are, as a rule, too bulky and require too long to prepare. With proper "reservoir" stations two drafts per minute could be easily maintained, say 100 per hour as a daily average. This would give 54 tons per boom system per hour.

OPERATING RECORDS POSSIBLE

If a ship's hatches are sufficient in number (say eight for a 14,000-ton ship) and two boom systems are used at the larger hatches (say twelve per ship), 650 tons per hour can be handled. In a ten-hour day 6,500 tons should be handled, or a 14,000 deadweight ton ship discharged and loaded (28,000 tons) in 4.3 days. I realize that this is so far beyond the present practice that it may seem impossible; yet this is only at the rate of 54 tons per hour per hatch, while I have shown that 70 tons per hatch came under my observation. With two hoists working in a 35-foot hatch it would probably be impossible to maintain a much higher rate than 54 tons per hoist; yet with nine hatches and one hoist per hatch working at the 70-ton rate, practically the same rate per hour for the ship could be maintained.

If a rate of 40 tons per hatch per hour were maintained with a 4-hatch ship, the rate would be 1,600 tons per 10-hour day in contrast to the above 6,500 tons.

For an 11-knot, 14,000 deadweight ton ship on a 4,000-mile run (allowing 30 days per year for repairs, overhauling, holidays, etc., and increasing the time in port 10 per-cent for delays), the slower cargo handling rate would give 9.8 single trips per year, while the faster rate would give 16.9 single trips per year. While these figures may be for extreme cases, and assume too theoretical conditions for labor, ports and land transportation facilities, etc., they nevertheless show the possibilities and point the way where profits can be made even at high first cost of ships.

ACTUAL RECORDS FOR CARGO HANDLING

The following loading speeds have been published from time to time and are of interest in connection with the above suggestions:

S. S. *Andrea Luckenbach* (loading), 14,290 tons deadweight capacity ; 450 tons per hour with twelve gangs of men, eight hatches and twelve kingposts in operation.

S. S. *Saxonia* (Boston), 190 tons per hour.

Stream unloading at Hamburg averages 250 tons per hour.

It should be noted here that the above shows the increase in "turn arounds" per year, but does not take any account of the reduced cost of handling per ton which certainly would result with increased speed of handling. This would further increase the profits per year.

What we need is a little study and attention to ship "turn around" and not the complete indifference too often existing today.

More "turn arounds" not only increase the shipowners' profits, but also allow a larger number of ships to dock at a given pier per year, thus reducing the pier overhead per ship and the dock charges to the shipowner.

Location of River Terminals

BY H. MCL. HARDING*

THE selecting of the proper site for the initial development of river terminals involves many considerations, but it may be said that the chief of all is the permanence of the substructure. The river frontage available for terminals at one inland river city extended for a distance of four miles. It was the desire of the city authorities that the first terminal units should be so planned, designed and constructed as to show the greatest possible net income return from the investment. There must, therefore, be the least cost of all the elements which go to make up a complete terminal.

If the first few units can prove that terminals are wholly self-supporting and add nothing to taxation, but rather produce an income with a reduction in terminal charges to the shipper and consignee, then the whole waterfront will be developed proportional to the demands of commerce and navigation. While it is true that the whole waterfront of this city may finally be improved, nevertheless the returns from the first unit will greatly influence the securing a continuous progressive development.

One location might require for a unit substructure fifty thousand dollars and another at a more difficult location four times as much to accomplish the same result. It frequently happens, however, that a desirable location near a civic center is rendered unstable by subsidence or sloughing of the banks. The following description of the subsidence of inland river banks is therefore written to secure economically the safety of river terminals, and may indicate how at a comparatively little expense the otherwise desirable location can be utilized and become permanent.

SUBSIDENCE

To insure the permanence and low cost of the quays and superstructures, often amounting to a considerable

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investment, more than the usual careful investigation was necessary than was possible by river commissions for river conservation, as the frontage for terminals is measured by hundreds of feet and for river conservation by hundreds of miles.

Many investigations, surveys and studies have been made of the waterfront of the city of Natchez and of the conditions at various cities along the Mississippi and intermediate bluffs and "highgrounds," also the banks of the Ohio River, of the Missouri River and of the city of Cincinnati, and what was there found confirmed the following, that:

First.—The subsidence of waterfronts and levees, where there is no erosion but rather accretions, is due to the action of the continuous or intermittent flowing or seepage of underground streams washing or wearing away the subsoil at a greater or less distance below the surface of the ground, the water being either from springs, lakes or from some form of drainage.

Second.—That these waters flowing from high grounds such as bluffs bordering on the river, from lands at a distance back from the river or from ponds or springs, find at a low level one or more layers of clay or rock wholly or partially impervious to water, and the water in its downward movement having reached this layer, either follows a narrow course just above it, thereby causing a gully or bayou, or if not confined laterally, spreads out fan-like and conveys away in its course earth or sand, leaving voids or cavities in the subsoil above. Here and there may be left supporting columns of material which resist the action of the flow or are less easily transported by the water which normally has a slow movement.

There may be several impervious layers with porous and softer material between them, and there may therefore be separate streams at different elevations.

Third.—When the normal flow of water is small or at great depth, a long period of time may be required to produce a marked subsisdence of the surface—in fact, the superincumbent earth may form small arches which prevent for the time being any surface settling. Again, the depth may be such or there may be impervious material above and below the flowing water that there may not be any settling.

Fourth.—When the waters in the river rise, the voids or cavities are filled with water both from the back lands and from the river, together of considerable volume, but there is no apparent effect on the surface soil until the river begins to recede.

The layers of soft earth, often being sponge-like above the impervious layers, become saturated, thereby adding to the weight, and when the river flood waters recede, then, in combination with the back-land streams, the flow is augmented in volume and speed and more material is water transported. Larger, wider and more extended voids are formed, and then comes the subsidence, generally following the stages of the receding waters. Sometimes there is mud or earth, immovable unless saturated with water. When it becomes practically fluid it is often called "gumbo." When the columns or arches are slowly removed by the water, the subsidence is gradual, otherwise it may be quite rapid, often several feet in twelve hours or less. In some cases there are sand and gravel; in others this soft gumbo clay, which latter being saturated either flows out or else is squeezed out, but only when completely permeated with water.

The subsidence in swamps due to this moving of subsoil clay is not to be treated by the same method as the banks of rivers.

To the presence of flowing water from springs, from drainage from the rear, or from a combination of the above with river water during the receding of the high stage of the river is therefore due this river bank subsidence. The river water cannot be kept from the subsoil, if there are waters flowing from high back lands.

Typical Illustrations

There are numerous examples confirming the above conclusions.

In one case there was a layer of impervious blue clay (erroneously called soapstone) extending about 13 feet above the local river datum, covering a large area and of more than 80 feet in thickness. Above this layer of grayish blue clay was a layer of material probably 40 percent sand and the balance gravel, and above this another layer of sand and then marl of the Loess formation. The sand and the finer gravel of the strata above the clay was gradually carried into the river and the heavier gravel remained.

The flowing springs were not of sufficient volume or force more than to remove the sand and earth, but the gravel remained until the flood waters penetrated the upper layers and then these upper layers were also washed away, after which came the disastrous settlement of the surface. The flood waters and the trickling springs completed the destruction and finally at low water the high banks above the impervious layer were gone and there were clear springs of cold water flowing over the river beach through and over a bed of well washed gravel above the impervious clay, where formerly, before the sloughing, were 20 to 30 feet of sand, marl and surface soil.

The past history of this case is interesting. This waterfront property was about 600 feet in length along the river and several hundred feet in depth or width at right angles to the river, and was occupied by buildings and accessories belonging to a municipality owned public utility. Back of this property there were permanent bluffs some 150 feet in height.

There had been an unobstructed spring of water of some considerable volume flowing into the river through the northern portion of the property, but by means of filling and revetment the flow of the spring was stopped and there were accretions here instead of erosion.

The flow of water, which had been only a small seepage through the central and southern portion of the frontage, almost immediately greatly increased, and soon there was here an undermining, sloughing and a falling away of the bank forming a curve into the land.

Various devices were tried to prevent this sloughing away, such as with cinder filling, bushes, by concrete walls to keep out the river water, and other customary methods, the river alone being supposed to be the prime cause, but the efforts produced no good results, and the speed of falling away became greater and the buildings and whole plant were endangered. These so-called protective barriers were undermined by the flowing back-land waters, and the high stage of the river contributed to the final result.

At another place in front of other property along the same river, where for many years there have been a subsidence and then a falling away of the bank, there have always been springs of considerable volume. The water of these springs, though clear, cold and tasteless, yet must have been impregnated with iron, probably a chloride or hydrate, as the iron in solution cemented the sand and gravel and gradually formed a layer above the blue clay, preventing for a time subsidence. With, however, the washing away of the sand, this cemented layer also gave

(*Concluded on page 933.*)

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Models and Their Lining Off

BY COMMANDER G. A. BISSET, C. C. U. S. N.

The best procedure to be followed in preparing half models for lining off and ordering the shell plates for a vessel is given in the accompanying article. Closely connected to this work is the use of glass slabs in the drafting room, on which the fairing of ships' lines may be carried out with sufficient accuracy to eliminate all mold loft work except the laying down of a full-sized body plan.

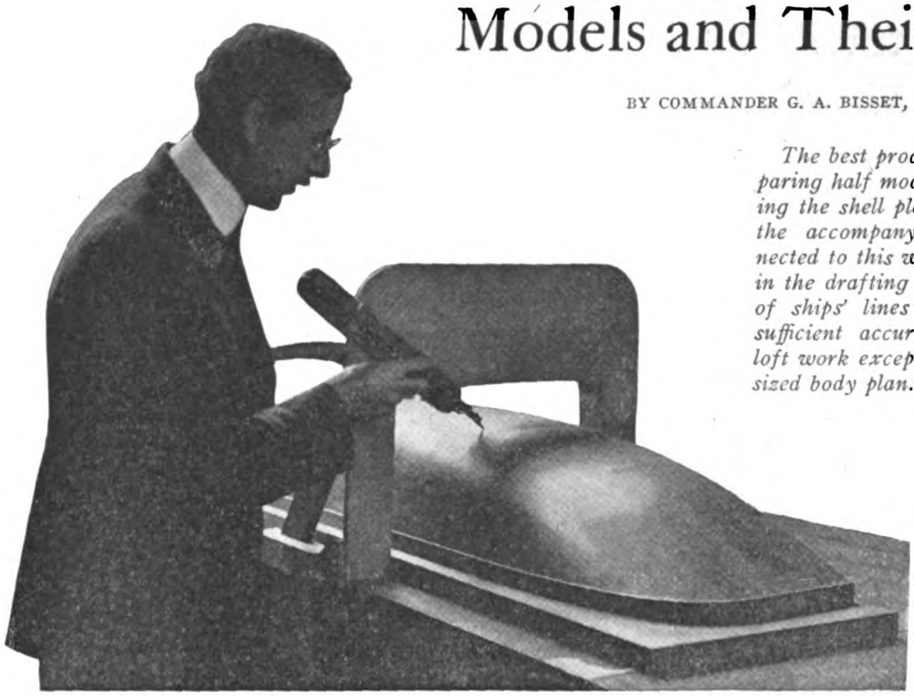

Fig. 1.—Actual Operation of Laying off Frames on Model Preparatory to Arranging Shell Plating

MODELS, or rather half models, of vessels are made in order that the shell plating may be ordered accurately to the dimensions required. On account of the curvature of the shell it is not possible to order this plating accurately from plans. Therefore, instead of ordering from plans and allowing an ample margin which would mean that there would be a considerable amount of scrap, it is considered much better practice to use a model, particularly at times such as the present, when the high cost of steel makes it imperative to keep the scrap down to the minimum.

Models are usually made on a scale of ¼ inch to 1 foot, although in the case of small vessels, such as tugs, ½ inch to the foot may be advantageously used.

The models are usually made in the pattern shop unless it is feasible to have them made in a shop attached to the Model Basin of the Washington Navy Yard, where special machinery for their manufacture is available. Thoroughly kiln dried sugar pine is the most satisfactory material to use, but No. 2 white pine will answer the purpose.

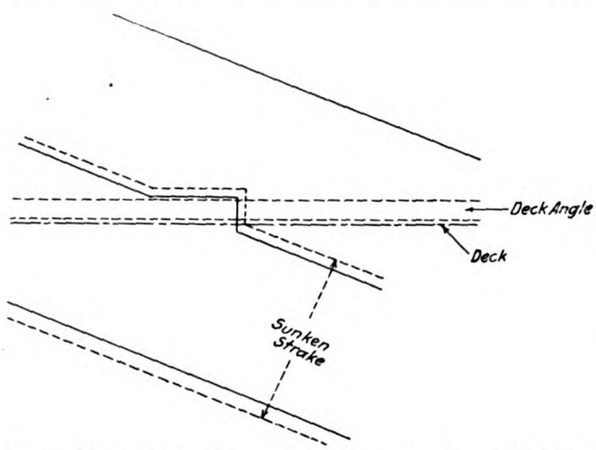

Fig. 2.—Method of Laying Out Strake so that Seam Laps Will Clear Deck Angle

Some time can be saved in ordering the material, if the model is made, in the case of vessels for the Navy, from the contract lines, in the Model Basin shop and sufficient accuracy is obtainable. If, however, any appreciable changes in the hull are contemplated, it is desirable not to start the model until the half breadth and body plans are faired up on the white glass slabs.

As in most cases it may be found necessary to make the half model in the pattern shop, the procedure will be described. The fairing up having been completed on the slabs, a scale of ¾ inch to the foot being used there, the offsets are obtained at the required number of stations, ten usually being sufficient with an extra half station at the bow and one at the stern. The offsets are obtained all the way up to the sheer line. These offsets are laid off to ¼-inch scale on cardboard and female molds made of the contour of the ship at each station. All the above is done in the drafting room.

These molds are sent to the pattern shop, which by this time should have completed the preliminary work of getting the material together, kiln drying it and glueing it together into a block large enough to make a half model of the ship with enough to spare so that the shape of the vessel may be extended ½ inch beyond the sheer line. This is necessary in order that the sheer line may be drawn in. In glueing the planks together to make the block, the contact surfaces of the planks are made to run horizontally—that is, parallel to the base line. The faying surfaces then become water planes, appearing on the surface of the model as waterlines. The pattern shop, having been provided with the molds and with the sheer, half breadth and body plans, proceeds to shape out the model. It is desirable to remind the shop that standard practice requires the bow of the model always to be *to the right*.

As soon as the model is completed, which should be in not over four days, it should be given two or three coats of clear—that is, white—shellac, not orange shellac. The

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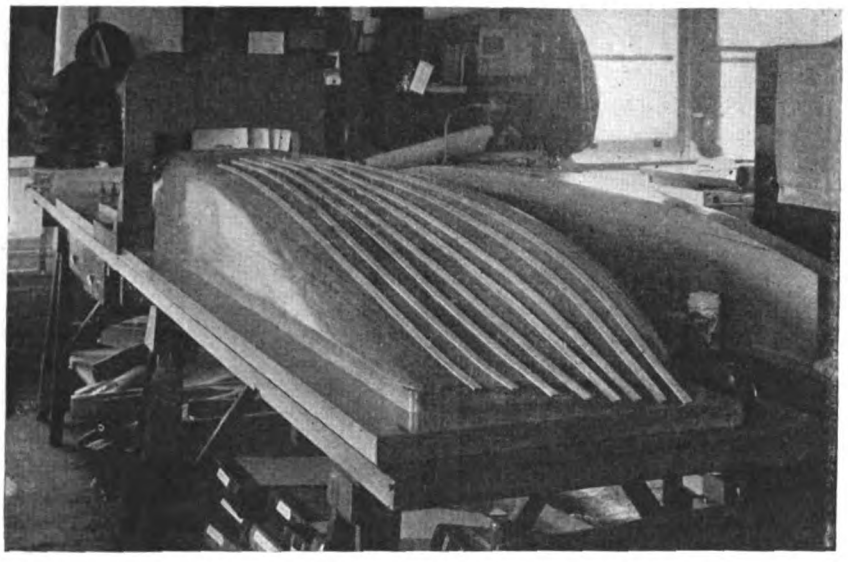

Fig. 3.—Battens Used to Line off Sight Edges of Shell Plating

shellac is applied (a) to make it keep its shape, (b) to prevent checking, and (c) to insure that the ink lines will not spread. White paint is sometimes used, but it takes much longer to dry than shellac.

The completed model is sent to the drafting room, where the lining off is done.

Lining Off

In lining off the model the carriage shown in Fig. 1 is used for putting in the frames. The bulkheads, decks, frames, etc., are first shown, then the keel, then the sheer strake, then the intervening strakes are laid off.

In laying off the other strakes much trial and error is resorted to in keeping the seam laps clear of longitudinals, decks, bilge keels, etc. Where these cannot be avoided they are jumped in the manner illustrated in Fig. 2.

Still more trial and error is necessary to obtain a good shift of butts. First a shift of butts is indicated for inner, outer and vertical keels and keel angles—that is (these angles having to shift butts also with each other), the butts in these keels are kept in different frame spaces. Next the port and starboard garboard strakes must have a shift of butts with reference to each other and the keel plates. In locating the butts in the other strakes of the shell it is desirable that three strakes intervene between strakes having butts in the same frame space. This point, however, is not so important towards the ends of the vessel where the bending moments in the vessel are not so great. Moreover, with the ever-present tendency to use wider and wider plates, it is becoming increasingly difficult to observe this ancient but important rule. As the lining off proceeds it becomes necessary to see that holes for air ports do not occur in frame spaces containing butts in the same strake. It is also important to avoid locating a butt within a frame space of watertight bulkheads or floors.

Later, when the inner bottom strakes are lined off it is desirable to get a shift of butts with reference to the outer bottom, and in the case of a vessel with a complete inner bottom extending up the sides a model similar to that for the outer bottom is necessary for ordering the material.

Fig. 3 shows the method of lining off sight edges of shell plating on the model.

Practical Hints

In laying off the shell plating on a model, the following points should be considered:

(a) The widths of plates that require furnacing should be kept within the capacity of the furnace—that is, normally they should not exceed 9 feet. To facilitate handling, such plating should be kept as short as possible.

(b) The length of plates that require rolling should not exceed the capacity of heavy plate rolls, usually about 30 feet is the maximum length.

(c) Plates other than the above should not be so wide as to be beyond the capacity of the punches in the shipfitters' shop.

(d) The length of plates should not be so great that the weight will exceed the capacity of the shop handling appliances, or such that the layout of shop tools will not permit them to be handled. Plates 36 feet long are ordinarily the longest that can be readily handled.

(e) Plates should be as large as shop facilities will permit in order to save riveting.

Ordering Material

In ordering plating from the model it is customary to add to the dimensions lifted from the model ½ inch to the width and 1 inch to the length. In case the plate as actually shown on the model is not quite rectangular, effort being directed to keep them as nearly rectangular as possible, it is the practice to order the circumscribing rectangular plate. In other words, sketch plates are not

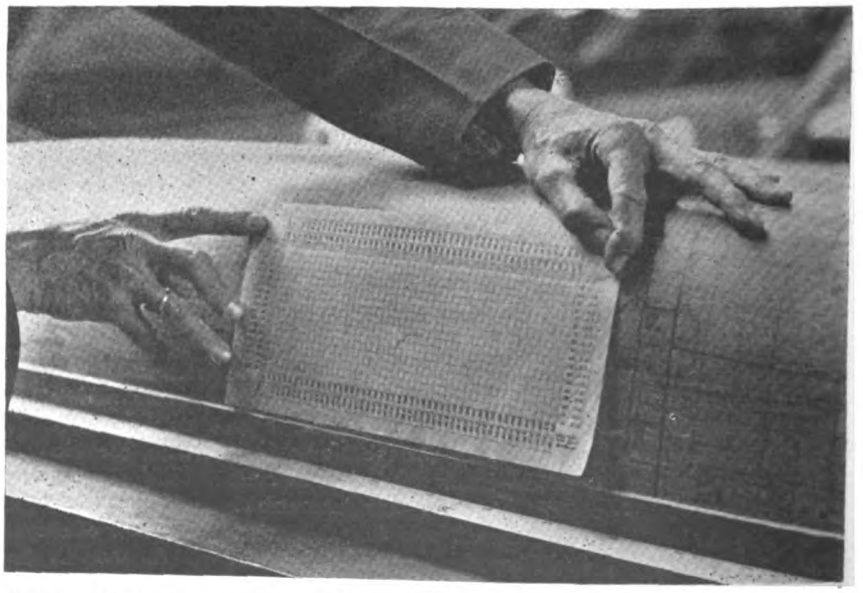

Fig. 4.—Laying Out and Taking Off the Shell Plating from a Model Showing Transparent Scale Used for Getting the Overall Dimensions of Plates

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ordered for shell plates, except possibly for a few plates at the bow and stern where the scrap would otherwise be excessive.

Fig. 4 shows a method for obtaining dimensions of plates from the model.

GLASS SLABS

Intimately connected with the use of models are the glass slabs that should constitute part of the equipment of every up-to-date ship drafting room. When the order to construct a vessel is received the first work undertaken is the fairing of the lines on the glass slab. Two glass slabs are required in the drafting room, preferably honed on both sides. For ordinary work slabs of the following sizes are required: One 54-inch by 54-inch and one 54-inch by 96-inch. These glass slabs, 1 inch thick, may be purchased from the Pittsburg Plate Glass Company under the following specifications: "Carrara Novas sanitary white glass, to have a honed finish on both sides and to be free from scratches, bubbles and all other defects which would render the honed surfaces unsuitable for drawing purposes. Edges need not be ground, but should be true enough to allow placing of each piece in separate wood frame."

The square slab is used for laying down the body plan, and the rectangular slab for use in laying down the half breadth and sheer plans.

The body is laid down to a scale of ¾ inch to 1 foot, the half breadth and sheer to two scales, the vertical scale being ¾ inch to 1 foot and the horizontal scale ¼ inch to 1 foot.

The "stations" are first laid down and faired up and molds made for the use of the patternmaker in making the half model of the vessel. The frames, waterlines, etc., are then faired. Later, the sight edges of the shell plating are faired, in connection with lining off these sight edges on the model.

After the fairing up is completed on the slab, tables of offsets are prepared and turned over to the mold loft for use in laying off the body plan full size. When, in the fairing up in the mold loft, errors are found in the lines taken from the slab, the table of offsets is corrected to agree with the mold loft fairing up. Very few corrections are usually necessary. Such corrections as are made usually occur in the vicinity of the tuck plate—that is, far aft where the frames have a considerable curvature near the upper part of the stern post.

It is found that great accuracy can be obtained by the use of glass slabs which have a snow white surface. It is necessary to use 9H lead pencils, 6H making too wide a line. Much better results are obtained with these slabs than could be obtained by use of drawing paper, which is much influenced by moisture, buckling badly over night, so that satisfactory accuracy cannot be secured.

While formerly lines of the vessel were faired up in the mold loft full size, a great deal of labor being involved in walking over this large area, satisfactory fairing is now done on the glass slabs in much less time at a much lower cost. It is now necessary to lay down in the mold loft, full size, only the body plan.

In connection with the use of the slabs a set of splines as follows will be required:

Six hard-rubber splines, 24 inches long.
Six hard-rubber splines, 36 inches long.
Six hard-rubber splines, 48 inches long.
Six hard-rubber splines, 60 inches long.

Location of River Terminals

(*Concluded from page* 930.)

way and then the action of the water was therefore the same as elsewhere on the layers of sand and marl. These layers of cemented material as exposed were from six inches to a foot or more in thickness and were of a deep reddish brown color.

In a location in front of another city, while there was being deposited a foreshore in front of the bank, gradually adding land, and with no erosion or sloughing of the banks, yet the levee and the land back of the levee were continually settling, even to the rear side of a marginal street which extended for a considerable distance parallel to the river bank.

There was in past years a subsidence of the southern portion of the levee, necessitating a constructing of other levees further inland and parallel to the first levee. The levees were very unstable. A large drain was dug for diverting the drainage from this southern portion of the city to a point below the southern limits of the city, and since then there has been no change in the elevation of this levee or any surface movement, and it has been permanent for the number of years since the drain was dug.

In the northern portion of the city no such sub-soil drain parallel to the river has been dug, and there is here a continual subsidence to this day.

Many other examples, the result of inspection and surveys, will later be given with a more satisfactory discussion.

CONCLUSION

The above, however, only comprises one feature among many as to securing the safety of future terminals. A large amount of money is now being appropriated to try to render safe a new river terminal poorly located.

From a study of results it is recommended:

First.—That there be borings made where possible to the depth of the layer of clay, rock or other impervious material to determine its existence and the presence or absence of flowing water. These borings should be made along a line to the rear of the area affected and parallel to the river. Sometimes the streams flow into the river below its surface and their presence can only be determined from the borings.

There should also be borings along lines at right angles to the river along the sides of the area or property as the water may enter from the sides.

These borings should extend to the impervious layers, which generally are not at great depths.

Second.—If water be found at a reasonable distance below the surface it should be confined and diverted by drains into the river so as not to spread and flow unconfined under the area affected. The drains may be composed of porous drain pipes with open joints laid in broken stone, and along the rear of the areas to be protected. Drains should also be constructed and connected at right angles to the rear drain, that the streams may flow without damage into the river.

To explain the details, exceptions and conditions which might occur and which could only be determined by a survey would require a long report.

Third.—There should be lines of stakes parallel and at right angles to the river, carefully levelled and in straight lines to determine the area of subsidence and any surface movements in any direction unless these have already been determined.

The above is only a rough outline of what should be done and naturally is subject to criticism as being incomplete, but from continued observations there is no doubt but that flowing waters or springs with the flood waters of the rivers form one source of surface subsidence.

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Loss of Efficiency with High Speed Propellers

WITH the introduction of steam turbines and internal combustion engines higher speeds of rotation of the propeller shaft have been accepted together with the loss of propeller efficiency that goes with it. Though this unavoidable loss of efficiency is well known, the reason does not appear to be so well known. Of course, the final answer to the question is that both experiment and practice show that a smaller pitch ratio involves loss of efficiency; but the question remains, why? The answer is friction and interference. The surface friction increases with the square of the velocity; that is to say, with the square of the number of revolutions for the same diameter. The blades of the propeller follow each other closer and the interference is greater. The effect of interference is well known from the comparison of two, three and four bladed propellers, the greater number of blades showing marked decrease of efficiency.

Increasing the Power of Diesel Engines

THE Diesel engine has been thoroughly adapted to marine propulsion and is regularly built both in America and Europe to such sizes as will develop three hundred horsepower per cylinder where running at a convenient speed of revolutions. This readily gives eighteen hundred shaft horsepower for a six cylinder engine. For smoothness of running, the six cylinder engine is ideal; eight cylinders give a somewhat more even turning moment but lack dynamic balance.

To increase power three expedients have been used—twin engines, gearing and the use of two cycle engines. There seems no reason why we may not expect a considerable advantage from the use of the two cycle engines; a number are in successful use, though as yet lacking the efficiency of the four cycle type. Gearing, of course, admits of higher speed, which, however, brings its own troubles. The use of twin screws, though more expensive, has been accepted for many of the larger ships; it cannot be made advantageous when steam engines are replaced by Diesels. The natural and desirable line of advance is to increase the size of the cylinder. As has frequently been pointed out, the difficulty is the disposition of the heat absorbed by the cylinder walls because the area does not increase in proportion to the volume, while the thickness of the metal must be increased.

It is reported that European builders are ready to supply four cycle engines to develop five hundred horsepower per single acting cylinder, and American engineers are seriously considering the matter. An idea worthy of consideration is the use of some special metal that can endure greater stress under the conditions of service for cylinder liners.

Recommendation for Purchasers of Fuel Oil

IN another column of this issue there is a recommendation that fuel oil should be sold on guarantee with proper analysis and reports by experts, and that companies selling such oil would find it good business to adopt such a policy. Just now, when there is a shortage of all kinds of fuel and when purchasers take what they can get and pay what is asked, may seem a poor time for urging that policy, but the policy is correct and will probably be adopted in the near future. The idea is not new, as purchasers of large quantities of coal have bought on specifications. There may be a question as to who should issue specifications and whether experts should be employed by the users or the producers, or whether independent experts would be preferred. The oil companies do and must employ competent experts, and it is believed that coal companies would find it profitable to do so. Corporations that need experts can afford to have the best, and, having the information for their own use, can most economically furnish it to the public. Some of the best scientific men in the country are in the employ of corporations, and it is to the advantage of both sides that such men should be given prominence; their reports concerning the properties of products of the corporation would command acceptance.

Business Secrets

THIS is a plea for greater frankness on the part of engineers and manufacturers, as a matter of policy for their own advantage. There is a very proper idea that a man may well keep his private business to himself and that corporations may well practice a like reserve. But when a man wants to sell something it at once becomes a matter of business to the purchaser. He wants to know all about it, and the more intelligent he is the more he wants to know, especially as the old Roman precept *caveat emptor* carries right down into modern business. There are, of course, instances in which the purchaser may well use his purchase without too much curiosity; the average man had best wind his watch regularly and think no more about it till he wants to know the time. But usually a machine needs intelligent care, and the more the user knows about it the better service he will get from it.

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Consider also the futility of excessive reticence. Intelligent users of various materials and machines already know a great deal about them and are keen enough to find out more. A certain concern bought a steam turbine and the engineer told his assistant to take certain measurements before it was erected. The erector sought to forbid this, but was informed that the machine belonged to the purchaser. Finally the builder sent blue prints of *another sized turbine* without dimensions. In less than half an hour the inquisitive engineer knew what turbine was represented by the blue print and what the scale of the drawing was.

Motorship Auxiliaries

THE installation of Diesel engines on ships at once brought the problem of the auxiliaries, including heating and cooking. Some of the earlier ships carried donkey boilers and had a full equipment of steam auxiliaries; and that method has advantages especially if the donkey boiler is set on an upper deck. The custom now is to provide an adequate electric plant with two or three Diesel driven generators; except on the smallest ships it is probably best to have three sets, one of which may be in reserve; and also it is very desirable that one set at least shall be on an upper deck, so that it may serve should the engine room be flooded.

It is long since electrical power was under suspicion; now properly designed and built electrical machinery is entirely reliable, requiring the minimum of attention. The auxiliaries on a motorship include pumps for all purposes, steering engine, cargo winches, anchor engine and capstans. Such auxiliaries are now regularly placed on the market and serve their purpose, though it is doubtful if any device is quite so satisfactory as the steam anchor engines or steam capstan. The steam engine has the advantage that its pull on cable or line is practically independent of speed; if line or cable comes too hard the engine will stall and start again when the line slackens. If engine and line are properly adapted to each other there is no danger of breakage.

We are so accustomed to the use of steam auxiliaries that they are accepted as a matter of course with all their wastefulness and inconvenience. Steam pipes in living spaces are a nuisance, and on deck waste more steam in heating the universe than they use for work. They are liable to freeze and give trouble when carried through bulkheads. Since steamships use ten or fifteen percent of the gross steam in the auxiliaries, the waste is a matter of importance; if it could be cut in half it might be able to keep a ship in commission when freight rates threaten a disappearance of profit.

The wastefulness of steam auxiliaries is well known, but may not always be appreciated. Large steam-pumps running at full capacity use sixty pounds of steam per horsepower hour; small steam pumps use from a hundred to a hundred and fifty; at reduced speed they may use double the amounts quoted. Nobody will quote the steam per horsepower for direct acting steam air-pumps, because no one knows for sure what the indicated power is. Their percentage of the main engine power under proper conditions may be so small that the steam consumption may escape notice.

The question of electric drive for auxiliaries on a steamship should be thoroughly worked out and advantage taken of the economy that may be possible. Considerable progress in this direction has already been made on warships.

Inland Waterway Transportation

AS an aid in overcoming the serious delays which exist today in the transportation of package freight and also as an aid in reducing the cost of transportation, William T. Donnelly, consulting engineer, New York, outlines elsewhere in this issue a new plan for the prompt dispatch of cargoes by inland water routes. This plan comprises a complete system of transportation by means of which the freight is taken direct from the point of origin and transported direct to the consumer. Briefly, it is proposed to transport the freight to a suitably equipped terminal on the nearest waterway by means of automobile trucks propelled by storage batteries. At the water terminal the freight is mechanically transferred from the trucks to a fleet of electrically propelled non-sinkable barges, the power for propulsion of the barges being supplied by an electrically propelled vessel carrying electric generating machinery of ample power. Upon arrival of the barge fleet at its destination, cargo for immediate delivery will be transferred from the barges by suitable mechanical appliances to electrically-propelled trucks for delivery direct to the consumer. In the case of cargoes not destined for immediate delivery the barges will be unloaded at a specially designed warehouse built on piling over shallow water. From the warehouse the freight can subsequently be delivered by electric trucks direct to the consumer. The various units which it is proposed to use have all been tried out and proved both practical and economical. As a matter of fact, the application of electricity to all the movements of freight in this system of transportation can be made with the same high operating economy as that obtained in central stations ashore or with the multiple unit trains on electrified railroads.

In proposing this plan of transportation, two objects of vital importance are sought—rapid dispatch of shipments and low cost of transportation. As an example of the feasibility of this system and the benefits which can reasonably be expected, Mr. Donnelly analyzes a specific case involving the movement of 800 tons of package freight in a fleet of four barges and one power boat between Schenectady, N. Y., and New York city at a speed of 9 miles per hour, showing that the cost of transportation to the operating company by this method is less than half the lowest freight rate and that the time of delivery is equal to that by express or motor truck under normal conditions and at least one-fourth of that by freight at the present time. In view of these benefits and the fact that this system of transportation provides a complete and independent service between the producer and consumer, the possibilities for its application wherever waterways, including canals, rivers, sounds and bays, are available are obviously manifold.

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NEW BOOKS

Motor Boats and Boat Motors

REVIEWED BY C. H. PEABODY, DR. ENG.

MOTOR BOATS AND BOAT MOTORS. By Victor W. Page, M. S. A. E., and A. Clark Leitch, N. A. Size, 6 by 9 inches. Pages, 524. Illustrations, 374. New York, 1920: The Norman W. Henley Publishing Company. Price, $4.

This book gives a popular exposition of boats and their motors for the owners of various classes of motor boats and pleasure boats. The range is large, since internal combustion engines are used for multifarious purposes by many people such as lobster-men, oyster-men, seiners, trawlers, coasters and freighters, together with a swarm of pleasure seekers in all kinds of motor boats and yachts, including hydroplanes and flying boats. The owners of all such craft are admonished to know something of their boats and engines, to the end that they may avoid trouble, or, being in trouble, to know how to get out of it.

A chapter is given by Mr. Leitch on the design of five popular types of motor boats, i. e., the tunnel stern boat, the V-bottom boat, the hydroplane, a 25-foot cruiser and a 16-foot general utility boat. This chapter has a purpose in that owners of boats should know enough of the construction and outfitting to be able properly to appreciate their boats. It is written as though amateurs were expected to build boats of the types illustrated from the instruction in the text. This is a good deal to expect of an amateur even had this chapter been expanded to the bulk of the entire volume.

All the rest of the book is edited by Mr. Page, the material for the several chapters being furnished by various experts. Attention is called to the fact that boats of moderate size are now comparatively inexpensive on account of standardization and quantity production, but even so, the purchaser is cautioned to beware and not buy a cheap boat. Such advice is good, as an amateur will have troubles enough with a good boat and motor. The prospective purchaser is advised to make up his mind exactly for what purpose the boat is to be used and what speed is desired; good advice, which may be best followed by an amateur who has had experience.

An important matter which may be new to some is that planks below the waterline may best be nailed with galvanized steel nails, a method said to be adopted for United States naval craft and one that is both economical and reliable; above the waterline copper riveting is advised.

Various types of open boats are illustrated—round bottom, flat bottom and dory type; also cabin boats that are probably dignified as yachts by the owners; and, further, there are types of speed launches and hydroplanes.

Chapters are given on hull construction and fittings. Excellent advice is given against overloading open boats. A rule to limit the number in quiet water to those that can be comfortably seated is not too drastic, nor the further advice that only half that number should be carried in rough water. Even better is the advice that an open boat should not be handled in rough water to send waves or even spray over the bow or sides. To follow this advice the skipper should be weather wise, lest he find he must drive his boat against a rising sea. The equipment with tops and spray hoods is convenient, with anchors if necessary, and with life preservers, horn, bell, lights and fire extinguishers is peremptorily required by law. It is at least convenient to have a compass and a log, and a sea anchor may be the last resort if caught in rough weather.

A further chapter gives the usual maritime customs and regulations for steam and other power vessels, as well as instructions for navigating by chart and buoy and for sailing by landmarks.

The second part of the book on motors and auxiliaries begins with an elementary explanation of two and four stroke engines, followed by illustrations of crank arrangements and firing orders for various types of multi-cylinder engines. Advice is given as to the choice of type and size of the motor, with a table of power capacities and speeds of various types and sizes of motor boats. Nine different well-known makes of motors are illustrated, including outboard motors and small Diesel engines; the latter type is described at length and its economy and other advantages are clearly pointed out. At present, however, such motors are not available except for sizeable yachts.

The proper working, or, in fact, working at all, of an internal combustion engine depends on a multiplicity of small details, any one of which may fail and stop the motor. Eternal vigilance is the price of motoring on land or sea, and a hundred pages is not too much for explaining the operation of vaporizers and carburetors, lubrication, electrical ignition by primary battery, storage battery or magnetos and dynamos. Diagrams are given of customary wiring and other arrangements which the owner is advised to learn, at least for the type of his own boat. Directions are given for starting and operating the motors, with cautions how to avoid troubles and how to meet them. A page is given of typical troubles and their remedies, if the engine refuses to start. There are nine of them, of which six are clearly cases of absent-mindedness and three are accidents that should not occur or should be forestalled. Reverse gears of the planetary type and electric starts are described in some detail.

A chapter is given on power plant installation, that is, of the engine and auxiliaries, and this is the proper complement of chapter five on design, as it is interesting to any owner, enabling him to understand his own power plant and perhaps to correct unfavorable conditions such as a tendency to squat at high speed. Besides the discussion of methods for lining up the engine, mention is made of flexible couplings, stuffing boxes, stern bearings, water pipes and fuel tanks, mufflers and underwater exhaust, and of bailing and pumping devices.

Besides the customary screw propeller, with or without a tunnel, illustrations are given of paddle wheels and air propellers. At the present time an air propeller is more or less of a freak, but the paddle wheel is a practical suggestion for shallow boats in muddy rivers, especially on an amateurish boat. Propeller design is treated in two pages, which is just as well, as an amateur may well buy engine and propeller together and is none too certain of a good job even then. For small boats, reversing propellers are simple and practical, with the advantage that weeds can be shaken off. It is remarkable that freak propellers persist, especially on small boats, though every marine engineer knows that the conventional form and proportions are most efficient and satisfactory. One such is mentioned which has one set of blades ahead of the other.

While the installation of the motor may well be left to the professional, every boat owner should know how to care for his engine and how to make adjustments or to remedy minor defects. In fact, the skipper is likely to find it necessary to make repairs to avoid great discomfort or even danger. This chapter is excellent, being clear and fairly complete. Of course, an amateur may well have personal instruction on the care of his engine, but as he will not get into trouble on purpose even with an instructor at hand, he will find much that is helpful in this chapter.

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The final chapter is on flying boats, giving a good introduction to this most recent water craft, or perhaps we should say air and water craft. In the fifty pages given to this matter, only a popular résumé can be expected. Those whose interest is sufficiently excited may find special books on this fascinating sport.

Governing of Prime Movers

REVIEWED BY C. H. PEABODY, DR. ENG.

GOVERNORS AND THE GOVERNING OF PRIME MOVERS. By W. Trinks, M. E. Size, 6 by 8¾ inches. Pages, 236. Illustrations, 139. New York, 1919: D. Van Nostrand Company. Price, $3.50 net.

This is the day of specialists, and the book under review is a book for specialists; in this case for the designers of governors. The author announces that it contains more than he gives his students. Under present conditions it would appear impossible to give any undergraduate class even in an option any large part of the work in the book. The author further promises another work on the dynamics and design of governors for prime movers.

In this book are given the modern investigations of French, German and Swedish engineers, together with the results of the author's personal experience from experiments made in the laboratories of the Carnegie Institute of Technology and in the field, in his efforts to help those who had trouble in regulation.

First the development of modern textile machinery and afterward the introduction of electrical generators called for greater refinement and certainty of regulation than could be had from the old Watt governor. Having one feature of governing in mind at a time, inventors have devised a great variety of governors in the last fifty years. In too many cases an inventor, even if well informed in general engineering, met with disappointment because he failed to provide other necessary properties to his governor than the special features which he might have originated. This may be illustrated by the failure of the isochronous governor, on which much ingenuity was wasted fifty years ago. The Watt governor allowed the engine to slow down slightly when the load increased; the evident remedy was to invent a revolving pendulum with constant height. The effect was that the governor had no stability and would not let the engine run steadily at any speed.

The earliest duty of the Watt governor was to control the throttle valve so that it was but little influenced by the engine except when the valve was nearly closed. But the introduction of the drop cut-off brought in another condition. Early catalogues of builders of these engines advertised that the governor's sole duty was to provide adjustments for releasing the drop mechanism; the engine did the rest. It was soon recognized that a powerful governor was required to hold against the releasing gear, which had the whole power of the engine behind it. The introduction of shaft governors acting directly on the valve gear by adjusting the eccentric or otherwise, together with the influence of the inertia of the parts of such governors that entered either incidentally or intentionally into the design, still further complicated the theory of the governor. All these and many other matters are dealt with by the author, including rate-of-flow and pressure governors; also the special problem of relay governors.

The author begins by pointing out that governors are speed measurers operating on the steam supply or on the valve gear; the relay governor shifts almost all the latter duty to some other source of energy. Attention is given first to centrifugal governors, especially of the Watt type, and of the many modifications of that type. As a motor, the governor must first overcome its own friction which habitually is made small. The author points out the facts (1) that friction is practically eliminated by jarring likely to be imparted to the governor, and (2) that some friction may be desirable in a governor. The author discusses the usual features of the strength of governors and the range of speed, and shows that such discussions are only the beginning of a very important study of governors.

To present the properties of governors, the author used characteristic curves as follows:

(1) Equilibrium speed against position of collar.
(2) The square of that speed against the position of the collar.
(3) Equilibrium speed against the radial displacement of the centrifugal weight.
(4) The square of that speed against the radial displacement.
(5) Centrifugal force against radial displacement of centrifugal weight.

The last method is preferred.

In the chapter on shaft governors (still important, though not so prominent as at one time) the author deals with the centrifugal moment of rotating masses, moment due to inertia of reciprocating parts, moment due to friction of valve gear, moment due to eccentric and strap, and moment of the springs. In this chapter consideration is given to the effect of tangential inertia, which steadies the governor against impressed forces and prevents racing and hunting.

Consideration is given to the natural period of vibration of the governor, which has importance should it concord with an impressed periodic force. For example, trouble occurs if a pendulum governor has a natural vibration with a period near that of the revolution of the engine. This chapter is followed by one on the effects of outside forces on governors, which may be of two sorts: (1) Resistance due to friction, and (2) devices which act cyclically on the governor. These matters being considered separately, the author takes up the very important matter of interaction between governor and engine, in which are discussed such matters as the influence of solid friction purposely applied and tangenial inertia.

The author has a chapter on discarded types of governors, so that people with inventive minds may be prevented from reinventing with the courage of ignorance mechanisms which were relegated to the scrap heap long ago.

Centrifugal pumps and turbo-blowers may give varying flow at constant speed and consequently require governors deriving a force from the flow itself. Examples of such governors are given without the theory. Constant pressure governors for pumping machinery in a similar way derive their force from the pressure; this matter receives a brief discussion. Relay governors are discussed at greater length.

From the author's own experience he gives a chapter on troubles and remedies which is very interesting and informing. In an appendix are given certain mathematical discussions which the author prefers to omit in the text with illustrative examples. There is also a most useful bibliography.

The author avows his desire to limit the size of the book to avoid an excessive cost. This appears unfortunate, since it leads to overconsideration and a dry, not to say arid, style. In fact, the book is hard to read; doubtless the author in the classroom provides the necessary dilution so that his students do not find it too hard. It is hoped that this will not be considered carping criticism of a book that is full of important and unusual information.

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Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY JAMES L. BATES

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Drawing Load Lines on Vessel in Dry Dock

Q. (1113).—Which is the simple and proper way of drawing the light and deep load lines when a ship is in dry dock?

A. (1113).—It is assumed that the draft of the vessel forward and aft for both the light and load condition is known. Then the waterline, either light or load, is the trace formed by the intersection of a plane perpendicular to that of the ship's central longitudinal plane and passing through the light or load draft points at either end of the vessel.

In drawing these lines upon the surface of the vessel the two following methods, or variations thereof, are frequently used:

For large vessels, see Figs. 1 and 2.

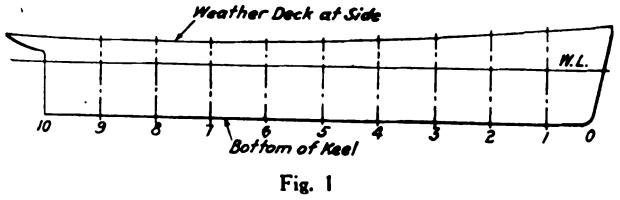

Fig. 1

Lay off the waterline desired, either on the sheer draft plan or on the mold loft floor.

Determine the distance x or y of this line, at the various stations throughout the vessel's length, from a fixed reference line, generally the bottom of keel or the line of weather deck at side.

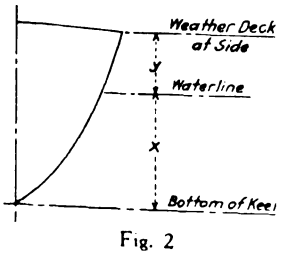

Fig. 2

Locate the stations on the ship itself, and locate on each at a proper distance from the reference line the point through which the desired waterline passes.

When a sufficient number of such points have been located, the required line may be easily drawn through them.

For small vessels, see Fig. 3.

Fix lines AB and CD at the forward and after perpendiculars respectively, each in a plane perpendicular to the vessel's longitudinal central plane, the first being at the desired draft forward and the second at the desired draft aft.

Between the guides AB and CD draw xy. If AB and CD are heavy straight edges rigidly secured in place and xy a chalk line tightly stretched, the latter may be so manipulated as to obtain the required spots on the vessel's hull in a very expeditious manner by moving x and y continuously inboard toward the stem and stern post along the guides.

Sometimes the waterline is to be slightly sheered up forward and aft. When this is to be done the methods above described are modified, in the first case, by laying

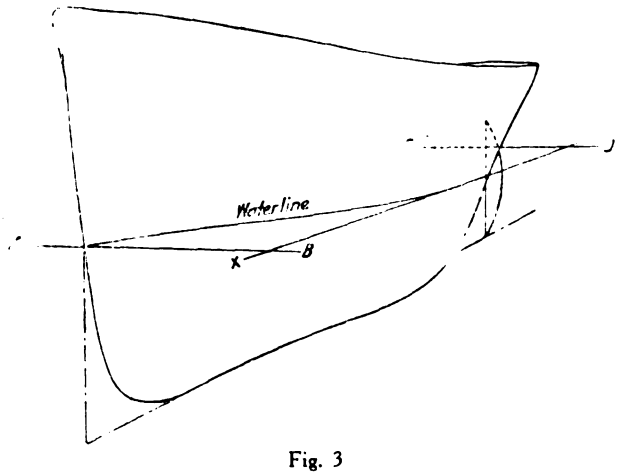

Fig. 3

off the original line on the sheer plan or in the mold loft to the desired curvature and measuring accordingly; in the second case, by permitting a proper amount of slack in the line xy.

Light and Load Draft of a Ship

Q. (1105).—Is there a way of finding out by the classification of ships as given by Lloyd's Register the light and load draft of a ship?

A. (1105).—Lloyd's Register gives the load draft to the center of the Plimsoll mark. It does not, however, give the light draft or any information from which it can be obtained.

From the nature of the information in Lloyd's Register, and from the fact that there exists some confusion, even among men generally familiar with ships, as to the exact meaning of the terms "tonnage" (particularly "gross tonnage"), "deadweight" and "displacement," it is assumed that you have in mind the possibility of using the tonnage figures for the derivation of displacement and deadweight and the obtaining of the light draft therefrom.

The *Shipbuilding Cyclopedia*, published by the Simmons Boardman Publishing Company, New York, gives the following definitions:

"Displacement is the amount or quantity of water displaced by a floating vessel. It exactly equals the weight of the vessel itself with whatever is on board at the time at which the displacement is recorded.

"Deadweight is the total weight of cargo, fuel, stores and water which a ship can carry when at her designed draft.

"Gross tonnage is the entire internal cubic capacity of a vessel expressed in tons of 100 cubic feet each."

That there can be no relationship between them which is sufficiently definite to be of value in deriving one from the other is evident from the following:

The light draft of a ship is the draft of the ship complete, ready for sea, with full outfit and equipment, but with no deadweight on board.

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The load draft is her draft when complete as above, but in addition carrying her full deadweight; that is, cargo, fuel, stores and water. The amount of her deadweight will be that deadweight carried when floating with the water surface at the center of her load line disk as fixed in accordance with "Instructions to Surveyors" by the British Board of Trade.

We may, then, state that the load displacement minus the deadweight equals the light displacement. Now, displacement in salt water, either load or light, in tons =

$$\frac{L \times B \times H \times k}{35},$$

where

L = the length on waterline;
B = the beam on the waterline;
H = the draft, and
k = the block coefficient.

Lloyd's Register gives L, B, H, but does not give displacement (either load or light), block coefficient or deadweight, so that while we may obtain the allowed load draft directly from this source, we do not get the light draft nor can we derive it.

The Register gives also the gross, under-deck and net tonnage. If it were possible to establish a relationship between any of these and deadweight and displacement, the light draft would be obtainable by substitution in the above equations.

The determination of tonnage in accordance with the present rules is essentially an attempt to ascertain the volume of the earning spaces of a ship. Briefly, the process consists of finding the total volume of hull to the weather deck, to the inside of ordinary frames and above the top of floors or inner bottom, plus that of enclosures above the weather deck, certain exemptions being allowed for galleys, wheel houses, latrines, etc. The figure thus determined is called gross tonnage.

Deductions from the gross tonnage are then made for spaces occupied by machinery, crew, fuel, navigational instruments, ship stores, etc., and there results a reasonable approximation to the volume of the cargo or earning spaces. This is termed the net tonnage.

Note now that in deriving the gross tonnage the double bottom spaces and those outside of inner face of ordinary frames and floors have been omitted, while the volumes of enclosures above the weather deck have been included.

Note also that two ships of the same dimensions, draft and load displacement, but differing in type and arrangement of decks and superstructures might have radically different values of gross tonnage.

Note again that two ships of the same type, dimensions and draft, but of differing degrees of fineness of underbody and therefore of different displacements, could readily be designed to obtain practically the same value of gross tonnage.

These are but instances of the possible variations in ship design and arrangement which make the establishment of a definite or even approximate relationship between gross tonnage and displacement impracticable.

In a similar manner the possibility of using the net tonnage is eliminated, because on account of its derivation from the gross tonnage it is subject to all the elements of uncertainty already described and in addition to those introduced by the several deductions allowed.

For example, two ships of the same dimensions, displacement and gross tonnage might easily have such widely varying deductions for machinery space as to give very different values of net tonnage. Or one might be designed for a long and the other for a short voyage, and the fuel space deductions be radically different.

Taking up now the subject of deadweight, the amount of which must be known in order to pass from the load to the light displacement, it is evident that neither the value of the gross nor of the net tonnage will be of assistance, as these are essentially volumetric conceptions, while that of deadweight is independent of volume.

Calculation of Bottom and Boot Topping Area of Ship

Q. (1114).—What method is used for calculating the bottom and boot topping area of a ship, both when afloat and when in dry dock?

A. (1114).—From the wording of your question it is assumed that you have in mind a method of estimating and not the actual measuring of areas from the ship.

In case you have a displacement sheet and lines and body plan:

You may measure to scale the perimeter of the waterline at the mean height of the boot topping and multiply the result by the mean width of the boot topping in order to obtain the boot topping area.

In order to obtain the bottom area (assumed waterline) in case no curve of wetted surface is given on the displacement sheet, you may use Admiral Taylor's formula:

$$\text{Wetted surface} = C \sqrt{\Delta} \times L.$$

In this formula Δ = the displacement in tons to the waterline in question, L = the length of the ship in feet on the waterline, and C a constant depending upon the ratio of beam to draft. Its value may be obtained from the following table, in which B and H are beam and mean draft respectively:

$B \div H$	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	$B \div H$
C	15.63	15.58	15.54	15.51	15.51	15.50	15.51	15.53	C
$B \div H$	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	$B \div H$
C	15.55	15.58	15.62	15.66	15.71	15.77	15.83	15.89	C

By means of this formula solved for values of displacement corresponding to drafts taken to the upper and lower limits of the boot topping, two values of wetted surface may be obtained. The difference between them will be the area of the boot topping. This method will serve as a check on that suggested above.

In case neither a displacement sheet nor lines are available, you can doubtless obtain a displacement draft scale which will enable you to use the methods just described. These methods, you will note, are independent of the vessel's position, whether afloat or in dry dock.

Gaskets and Packing

Q. (1,052).—What type of packing is best for the plungers of fuel oil pumps of the usual type, i. e., duplex pumps with inside packed plungers?

What style of packing is best for the stuffing boxes of the piston rods of the fuel oil pump? We have been using ordinary spiral steam piston rod packing.

Kindly give formula for a white paint which will stay white under the heat of the cylinders of the main engine, etc. K. W. W.

A. (1052).—The writer has found that an oil pump plunger fitted with bronze piston rings has given very good service. In regard to rod packing, a somewhat similar situation holds, i. e., a metallic packed plunger rod which many pump makers fit to fuel oil pumps will have a very long life under proper conditions. The rod packing you are using should answer very well.

A white lead paint mixed with linseed oil will turn yellow under heat. If zinc white is used and mixed largely with turpentine, it will withstand a fairly high temperature.

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PERSONAL MENTION

WILLIAM A. DOBSON, naval architect of Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., is chairman of the committee on classification, appointed by the Atlantic Coast Shipbuilders' Association, which will co-operate with the American Bureau of Shipping.

LIEUTENANT-COLONEL GEORGE C. COOK has recently been appointed naval architect of the United States Mail Steamship Company, New York City. Lieutenant-Colonel Cook is a graduate of the first class at Webb Academy, New York City, in 1897, later graduating in naval architecture and marine engineering from Glasgow University, Glasgow, Scotland. At various times between the years 1897 and 1901 he was engaged as a ship draftsman for the Wm. Cramp & Sons Ship and Engine Building Company, Philadelphia, and in charge of the design of harbor craft and troop transports for the Howaldts Werke, Kiel, Germany. From 1901 to 1906 he conducted a ship brokerage and naval architect's office in New York City, designing and superintending the construction of various commercial vessels and yachts. During this period he delivered a series of lectures for the Board of Education of New York and acted as an instructor in naval architecture and marine engineering in the New York Nautical College. Until the war broke out in 1917 he was assistant engineer and superintendent of construction of the marine division of the United States Lighthouse service, designing and supervising the construction of vessels for this service at various shipyards. When the Emergency Fleet Corporation was formed, Mr. Cook was released from the Lighthouse Service to become chief technical aide of the corporation, acting as assistant to the chief of the department of general commandeering, appraising values of commandeered vessels in all stages of completion. He was released from this service to enter the army for duty in France, first as a major and later as a lieutenant-colonel. In this connection he was chief vessel repair officer of the American Expeditionary Forces, organizing and operating large vessel repair units, including the personnel and shops at St. Nazaire, Bordeaux, smaller units at Marseilles, La Pallice, Le Havre and Brest. For his work with the army he was awarded a citation by General Pershing "for exceptional meritorious and conspicuous service." Following his release from active duty in October, 1919, until recently he was an inspector in the construction and repair department of the United States Shipping Board, engaged in preparing specifications and plans for the reconstruction of ex-German passenger vessels, surveying and reporting all classes of damage, estimating cost of repairs and valuations, supervising repair work, handling bids for work and performing the miscellaneous duties of a general inspector. Lieutenant-Colonel Cook is a member of the Institution of Naval Architects, London, England, of the Royal Societies Club, London, England, a former member of the American Society of Naval Architects and Marine Engineers, of the Congress d' Architecture et de Construction Navales, and of the Union de Langues Francaise, Paris, France.

Lieut.-Col. George C. Cook

N. KARFVE, former assistant general manager of the Pusey & Jones Company plant, Wilmington, Del., has left the service of this company for an extended trip through Europe.

PAUL J. KEIFER, formerly assistant professor of steam engineering, University of Illinois, is now associate professor of mechanical and marine engineering, postgraduate department, United States Naval Academy, Annapolis, Md.

HOWARD G. COSGROVE, of Seattle, has resigned from the position of counsel for the Emergency Fleet Corporation for the states of Washington and Oregon.

ERSKINE WOOD, of Portland, Ore., has been appointed Admiralty Counsel of the United States Shipping Board to succeed Charles F. Dutch, of Boston.

J. HARRY PHILBIN, of Baltimore, Md., has been promoted from acting sales manager to manager of the ship sales division of the United States Shipping Board.

WILLIAM GATEWOOD, naval architect, Newport News Shipbuilding and Dry Dock Company, is chairman of the Atlantic Coast Shipbuilders' Association committee on standard forms of contract for new construction and repair work.

CAPTAIN FRANK E. FERRIS, special commissioner for the Shipping Board in London, is in charge of all European offices of the Shipping Board, and according to a recent statement of Admiral Benson, is creating an efficient organization abroad. Captain Ferris formerly was with the Export Steamship Company, New York.

R. A. DEAN, formerly general counsel of the United States Shipping Board, has been appointed assistant to the chairman of the Shipping Board.

R. A. Dean

ROBERT M. GATES has been appointed managing engineer in charge of the Philadelphia, Pa., district of the Lakewood Engineering Company, Cleveland, Ohio, with offices at 1034 Widener building, Philadelphia. Mr. Gates is a graduate of Purdue University. He has been active in organizing the material handling section of the American Society of Mechanical Engineers and is acting as chairman of that section during its period of organization. He has devoted the past twelve years to the design and engineering surveys of mechanical means of conserving labor in the construction, industrial and transportation fields.

HENRY NEWKIRK WINNER, formerly manager of the Philadelphia branch of the Garlock Packing Company, has been placed in full charge of the packing department of the United States Rubber Company, 1790 Broadway, New York.

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Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

AMERICAN YARDS DELIVERED 34 VESSELS IN SEPTEMBER

Shipping Board Received An Aggregate of 246,225 Tons Including 30 Large Steel Steamers—Launchings Showed a Decline

American shipyards delivered thirty-four new vessels, of which thirty were large steel steamers, to the Shipping Board during September. They aggregated 246,225 deadweight. Two concrete tankers—the Palo Alto, built by the San Francisco Shipbuilding Company, and the Cuyamaca, built by the Pacific Marine and Construction Company, both of 7,500 deadweight tons—were delivered for operation. The largest vessel on the list, the Trinity, a steel tanker of 11,375 deadweight tons, was built by the Newport News Shipbuilding and Dry Dock Company and was one of seven tankers turned over during the month.

Another American shipyard completed its contracts for the board. The Union Construction Company delivered the 9,400 ton freighter Heber on the last day of the month. The California shipyard built ten freighters of this type for the Emergency Fleet Corporation. The Usaga Dock Company, one of the Japanese shipyards which aided the government in its creation of a merchant marine, wound up its work with the completion of the 5,500 deadweight ton freighter Eastern Sword. The company built four steamers of this type.

While the deliveries exceeded 200,000 tons, the launchings dropped considerably. Only nine ocean-going steamers of an aggregate deadweight register of 78,830 tons were put afloat. The largest was the 13,000 ton combination freight and passenger liner Wolverine State, which is being produced by the New York Shipbuilding Company at its Camden yards.

Following are the ships launched and delivered:

LAUNCHED

Name and Builder	D.W.T.
Lake Gano, Saginaw S. B. Co.	4,080
Yalza, Merchant (Bristol) S. B. Corp.	9,000
Wm. Penn, Pusey & Jones Co.	12,500
Wolverine State, N. Y. Shipbuilding	13,000
Syros, Geo. A. Fuller Co.	9,600
West Honaker, Los Angeles S. B. & D. D. Co.	8,800
Moffet (concrete tanker), A. Bentley & Sons Co.	7,500
Memnon, Hanlon D. D. & S. B. Co.	5,350
Geo. E. Weed, Merchant (Bristol) S. B. Corp.	9,000

DELIVERED

Name and Builder	D.W.T.
Carplaka, Hog Island	7,500
Carabrille, Hog Island	7,500
City of Fort Worth, George A. Fuller Co.	9,600
Half Moon, Newburgh Shipyards Corp.	9,000
Trinity (tanker), Newport News S. B. & D. D. Co.	11,375
Yaka, Merchant (Bristol) S. B. Corp.	9,000
City of Freedom (tanker), Baltimore D. D. & S. B. Co.	6,000
City of Lordsburgh, Mobile S. B. Co.	5,000
Tomalza, Hog Island	7,500
City of Weatherford, Pensacola S. B. Co.	9,000
Castana, Hog Island	7,500
Derblay, Hanlon D. D. & S. B. Co.	5,350
Cody, Hog Island	7,500
Palo Alto (tanker), San Francisco S. B. Co.	7,500
Pachet, Atlantic Corporation	6,800
Cuyamaca (tanker), Pacific Marine & Const. Co.	7,500
Catahoula, Hog Island	7,500
Manatawny, Hog Island	7,500
Gateway City, Merchant (Bristol) S. B. Corp.	9,000
Bidwell (tanker), Baltimore D. D. & S. B. Co.	10,300
Stockton (tanker), Moore S. B. Co.	10,000
West Canon, Western Pipe & Steel Co.	8,800
Hybert, George A. Fuller Co.	9,000
Glenora, Bethlehem (Harlan) S. B. Co.	7,400
Halway (tanker), Bethlehem (Alameda) S. B. Co.	10,100
Hastings, Pensacola S. B. Co.	9,000
Lavada, Pacific Coast S. B. Co.	9,400
Provincetown, Groton Iron Works	9,400
Heber, Union Construction Co.	9,400

Oriental Navigation Buys Another Coal Mine

The Oriental Navigation Company has purchased the property of the Orinoco Mining Company, of Orinoco, Ky. This property represents some of the best veins of steam coal in West Indiana and Kentucky, and gives the navigation company coal holdings aggregating approximately 2,000 acres, with an estimated 10,000,000 tons of coal unmined. The average production of the mines of this company, together with the William-Pocahontas mines at War, W. Va., recently purchased, is now 7,500 tons per day.

Tanker Orders on Pacific Coast

The Standard Oil Company of California has placed a contract for three 15,000-ton deadweight tankers with the Union (San Francisco) plant of the Bethlehem Shipbuilding Corporation, Ltd.

Work is to be started on the oil carriers immediately, and it is anticipated that the first vessel will be delivered in May or June of 1921. The other two will be delivered during the summer months.

This is the largest single order for tank steamers placed by an American company within the past few weeks.

FOUR NEW MEN NAMED

Benson Remains as Chairman of Shipping Board

Five of the seven members of the new Shipping Board were appointed on October 21 by President Wilson.

Admiral William S. Benson, chief of naval operations during the war, was reappointed chairman. The other four members named were: Frederick I. Thompson, a newspaper publisher of Mobile, Ala.; Gavin McNab, an attorney of San Francisco; Martin J. Gillen, an attorney of Wisconsin, and Theodore Marburg, a publicist of Baltimore.

Mr. McNab and Mr. Marburg both declined to serve.

The members of the new board are to receive salaries of $12,000 a year and under the law they must divest themselves of all shipping interests and devote all of their time to their work as shipping commissioners.

Two of the seven members must be named from the Atlantic Coast, two from the Pacific Coast, one from the Gulf region, one from the Lake region and one from the interior. This leaves one appointee from the Pacific Coast and one from the interior still to be named.

The appointments aroused no enthusiasm in New York shipping circles.

NEW OPERATING TERMS

Shipping Board Agreement Retroactive to March 1

With the statement by Admiral Benson that the Shipping Board intends that there shall be no further changes in the arrangements between the Board and ship operators, the new agency terms have been announced officially.

Carrying the provision that the agreement is retroactive to March 1 last, the new contract provides for compensation at the rate of 5 percent on gross outward freight, dead freight demurrage, express and mail revenue, but only 2½ percent on full cargoes of grain, coal, sulphur and phosphate; 2½ percent only is to be paid on full cargoes of other commodities sent from one shipper to one consignee; 2½ percent is to be paid on gross inward freight, dead freight demurrage, express and mail revenue, with a minimum fee of $250 at each port where cargo is discharged. These provisions apply coastwise between United States ports, except in the New England coal trade, where the agent

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is to receive only 2½ percent on outward freight and nothing on inward.

Between ports other than the United States 2½ percent is allowed on gross outward freight and the same on inward. Five dollars a day with a minimum of $50 is allowed on ballast voyages.

The contract allows $25 a day beyond ten days for vessels under repair. Ten percent is allowed on gross passenger and excess baggage revenues, with the exception that 5 percent only shall be paid on gross passenger and excess baggabe revenues on cargo vessels.

The contract also provides for the payment of commissions on freight, passenger and carrier brokerage where these are properly incurred in accordance with the usages of the trade.

Shipping Board to Make Repairs

The Shipping Board announces that in the future it plans to make all incoming voyage repairs to vessels and such other repairs as may be necessary to retain class. This policy will revise the "as is" clause in future sales of new steel vessels, but does not apply to the sale of vessels which are in need of such extensive repairs that the board would not be justified in assuming the cost.

Maine Steamer Lines May Be Sold

Elwell S. Crosby, of Bath, Me., heads a group of business men of that city who have obtained an option from the Eastern Steamship Company on two of its steamship lines—from Boston to Bath, and from Bath to Boothbay. The Boston-Kennebec service has been discontinued for some time.

The property to be disposed of includes the steamers *City of Rockland* and *City of Bangor* for the Boston and Kennebec line; and the *Wiwurna* and *Catherine* for the Boothbay Harbor division. In addition to the steamers are wharf properties, rights and privileges at Augusta, Hallowell, Gardiner, South Gardiner, Richmond, Dresden and Bath, these being the regular landing places of the Boston and Kennebec steamers in the past. The Boston end of the line would be secured by the rental of wharf privileges, which is also covered in an agreement.

Other wharf properties, rights and privileges covered by the option are at Southport, Westport, Westport Junction, Sawyer's Island and Boothbay Harbor.

Merger for Waterways

A merger of the Mississippi Valley Waterways Association with the Mississippi Valley Association was effected at a meeting of the directors of these two organizations in St. Louis on October 2. Under the terms of the merger, James E. Smith, president of the Mississippi Valley Waterways Association, will become head of the newly created Waterways Division of the Valley Association.

FAMOUS NAME RETAINED

Great Lakes Engineering Works Stronger Than Ever

It is regarded as significant to the shipbuilding industry that the reorganization of the Great Lakes Engineering Works has been completed, and the concern "will continue, as heretofore, the business of designing, building and repairing ships." An interesting fact in this connection is that the employees of the company, on their own initiative, have subscribed for over one-third of the entire capital stock of the company, which was transferred to them at the cost price paid for the properties and immediately paid for. This is a unique event in the history of the shipbuilding industry of the world.

Antonio C. Pessano, for many years an outstanding figure in American shipbuilding, possessed of a host of personal friends, and admired for his executive ability and foresight, is the head of the new undertaking, as he was of the old. He is a vice-president of the American Bureau of Shipping and a life member of the Society of Naval Architects and Marine Engineers, besides holding other important maritime connections.

At a stockholders' meeting at the River Rouge shipyard the old corporate name "Great Lakes Engineering Works" was readopted, and six directors were chosen, making the full directorate as follows: Antonio C. Pessano, John A. Ubsdell, George B. Turnbull, Frederick G. Morley, C. Henry Hecker, T. W. Palmer Livingstone and Joseph Boyer, Jr., all of Detroit, Mich.; Isaac W. Frank, of Pittsburgh, Pa., and John T. Webster, of Cleveland, Ohio.

The directors have elected these executive officers: Antonio S. Pessano, chairman of the board; John A. Ubsdell, president and general manager; George B. Turnbull, vice-president and assistant general manager; John T. Webster, vice-president; Frederick G. Morley, secretary and treasurer.

The following appointments have been made: Charles E. Baisley, manager, River Rouge shipyard; Frank C. Pahlow, manager Ashtabula shipyard; Robert Jackson, manager, Detroit Engine Works; Charles Short, secretary to the president.

Five Piers Taken From Shipping Board

An executive order by President Wilson, under the new Merchant Marine Act, exempts Piers 1, 4, 5, 6 and 11, and others, formerly owned by the North German Lloyd and Hamburg-American steamship companies, and the Hoboken Shore Railroad, from the control of the Shipping Board, which was, on January 1 next, to take control of all government docks, warehouses, and other marine transportation facilities not exempted by the President. The piers numbered have been leased by the War Department to the Panama Steamship Lines.

This order caused considerable surprise in New York shipping circles, as preparations were under way by local representatives of the Board to use the docks after January 1 for several lines of government owned or controlled vessels which are now hampered by crowded dock conditions. One of these lines is now using a Hoboken terminal in its South American service.

SEATTLE YARDS PROFITED

Alterations to Japanese-built Vessels Kept Them Busy

When the repairing and alteration of Japanese-built steamers on Shipping Board account at Seattle is completed, which will be when the *Eastern Sword* is delivered to the Board, more than $1,720,000 will have been spent in Seattle yards, in sums ranging from $34,134 to $135,220.

Yards handling the work comprise the Todd Dry Docks, Inc., the Skinner & Eddy Shipbuilding Company, J. F. Duthie & Co., and the Pacific Coast Engineering Company. By yards, the ships and contract prices follow:

Todd Yard—*Eastern Guide*, $71,000; *Eastern Gale*, $65,866; *Eastern Victor*, $67,000; *Eastern Admiral*, $51,500; *Eastern Tempest*, $48,605; *Eastern Importer*, $110,381.

Pacific Coast Yard—*Eastern Moon*, $34,134; *Eastern Marine*, $61,590; *Eastern Pilot*, $45,000; *Eastern Glade*, $72,500; *Eastern Cloud*, $67,225; *Eastern Maid*, $47,500; *Eastern Sailor*, $138,220; *Eastern Soldier*, $82,500; *Eastern Temple*, $62,100; *Eastern Leader*, $85,500.

Skinner & Eddy—*Eastern Knight*, $81,881; *Eastern Crag*, $53,980; *Eastern Ocean*, $67,499; *Eastern Planet*, $54,400.

Duthie Yard—*Eastern Crown*, $65,450; *Eastern Dawn*, $51,498; *Eastern Glen*, $59,150; *Eastern Exporter*, $101,996.

BALTIMORE YARDS BUSY

Tankers Orders Aggregating 190,000 Tons in Sight

Construction of bulk and ore carriers is providing a good quantity of present work and rosy prospects for the future in the big shipyards of Baltimore, and officials of the Baltimore Dry Docks & Shipbuilding Company explain this as being the result of the increasing use of oil as fuel for ships, and Baltimore, with increasing commercial and marine facilities, is expecting soon to rival the world's largest shipbuilding ports in the construction of oil and ore carrying ships.

The Dry Docks Company has six tankers under construction; the Bethlehem Shipbuilding Corporation has started work on a series of ships of 20,000 tons each, built to carry either oil or ore; the Union Shipbuilding Company is building ore carriers for the Aluminum Company of America, and the Globe Shipbuilding Company, which has been operating since June 1, is at work on two tankers of 8,600 deadweight tons each.

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U. S. YARDS LEAD IN TANKER TONNAGE AND VESSEL SIZE

Construction 1097 Percent Over Pre-War Figures, But Not Keeping Up With British Yards in Total Production

American shipyards to-day are further behind the British yards in the total amount of tonnage under construction than they were before the war, says a statement issued by Lloyd's Register of Shipping. This does not mean that American shipbuilding is returning to the small position it held in the world's output of tonnage in pre-war times, but it indicates how sharp the decline has been from the maximum production figure attained by this country during the war.

Even on the present reduced scale of output, however, the tonnage building in American yards represents an increase of 1097 percent over the total being constructed just prior to the war, while the British gain in the same period has been only 116 percent.

The great advance of American shipbuilding over the pre-war status of the industry, the subsequent sharp decline, and the course of British shipbuilding, may be shown by the following figures giving in gross tons the totals under construction for the two countries at the dates named. The peak of the American output was reached in the quarter ending March 31, 1919:

	June 30, 1914	March 31, 1919	Sept. 30, 1920
British	1,722,000	2,255,000	3,731,000
American ..	148,000	4,186,000	1,722,000
	*1,574,000	†1,931,000	*1,959,000

* British lead. † American lead.

Compared with the pre-war figures, American shipyards are now building 1,623,000 gross tons more and British yards, 2,000,000 tons. At the maximum of the American effort, however, the gain over the 1914 figure was in excess of 4,000,000 tons, so that the present figure marks a decline of nearly two and a half million tons.

Returns made by Lloyd's Register for the quarter ended September 30, however, indicate that in some respects American shipyards still lead the world. The chief demand at present is for tanker tonnage and in this type of construction the United States is building more than double Great Britain and all the rest of the world put together, as the following table shows:

	Number	Gross Tons
United States.....	79	545,302
United Kingdom.....	32	232,758
Other countries.....	3	18,000
World total.....	114	796,060

Another point in which this country leads is in the average size of the vessels under construction. Taking steel steamers, Lloyd's Register returns show that while Great Britain is building 912, aggregating 3,715,000 gross tons and the United States only 280, totaling 1,735,000 tons, the average size of the British steamers is only 4,074 tons, as against 6,197 tons for the American vessels. Of the 921 steamers building in the United Kingdom, 551 are of less than 4,000 gross tons each. Great Britain, however, is building a number of large ships, 25 of those under construction being of 15,000 tons and upwards, and 64 of 10,000 tons and above.

American construction is now being practically entirely devoted to steel steamers, Lloyd's Register returns show for the various districts of the United States, the figures representing gross tons:

	All Types	Steel Steamers
Atlantic Coast....	1,241,000	1,229,000
Pacific Coast.....	342,000	331,000
Gulf Coast.....	155,000	141,000
Great Lakes.....	34,000	34,000
Total	1,772,000	1,735,000

Wooden steamers under way represent only 18,000 tons of the American total, compared with 1,169,000 tons two years ago and 211,000 tons one year ago. About the only country paying any attention to this type of vessel to-day is Italy, where 47, aggregating 20,000 tons, are under way.

Classification Rates Up

Lloyd's Register of Shipping and the British Corporation have increased their charges for classifying ships, and the American Bureau of Shipping has appointed a committee to consider the advisability of following the lead of the other two societies. It is reported that the charges are nearly doubled under the new scale.

The cost of the service rendered by the classification society is relatively a very small item in the total value of a ship. Roughly speaking, the societies charge about $2,800 for classifying and surveying a 10,000 deadweight ton freighter. The fee of 25 cents a ton is exacted for inspecting the materials entering into the ship.

Permanent Marine Exposition Planned

Chas. Cory & Son, Inc., of 183-187 Varick Street, New York, are planning to establish, in a section especially constructed for the purpose, a permanent marine exposition for the display of ships' electrical and mechanical telegraph systems, lighting equipments, instantaneous-reading shaft revolution indicators, engine direction indicators and revolution counters, watertight marine loud speaking anti-noise telephones, the anticipating and emergency marine governors, control systems for floating dry docks, fire alarm systems, and all other signalling and communicating systems required for naval or merchant ships.

BUSINESS NOTES

The Morris Machine Works, Baldwinsville, N. Y., has opened a new office at 1630 Real Estate Trust Building, Philadelphia, Pa.

Raymond E. Lovekin, advertising engineer, is now occupying new quarters in the Fuller Building, 10 South 18th Street, Philadelphia.

Col. George C. Cook, naval architect for the United States Mail Steamship Company, 45 Broadway, New York, is in the market for catalogues, literature, samples, etc., for the work of his office in connection with the reconditioning of several of the large ex-German liners which have been taken over by his company.

The Lancaster Steel Products Corporation, of Lancaster, Pa., has opened a New York office in the National Association Building, at 25 West 43d Street, in charge of Mr. L. E. Vesey, as district sales manager. Mr. Vesey comes to New York from the Chicago office. This office, together with the Hartford, Conn., Detroit and Chicago offices, will enable the corporation to more adequately take care of its rapidly growing business in the cold rolled and cold drawn field.

The continuing activity and prosperity of the electrical industry is shown by the volume of business reported by the Western Electric Company, 195 Broadway, New York, whose sales for eight months of the current year in domestic billings showed a total of $119,500,000, indicating sales for the year of approximately $190,000.000, not including export business nor sales of its foreign affiliated companies. The export and foreign business will probably reach $38,000,000, bringing the total business up to more than $225,000,000 for the year.

Seabury & de Zafra, Inc., consulting naval architects and marine engineers, 150 Nassau Street, New York, have enlarged their offices in order to better accommodate their business, which has been developing rapidly during the past few months. Contrary to a prevailing impression, Mr. Charles L. Seabury has no connection with the shipyard which formerly bore his name. Murray S. Webber, formerly with the Merchant Shipbuilding Corporation, Chester, Pa., has joined Seabury & de Zafra.

The Diamond Power Specialty Company, Detroit, Mich., has available for distribution a special stereopticon lecture entitled, "Increasing Marine Profits," prepared by Robert June. The lecture is devoted to the possibilities of increased boiler efficiency, and deals with various phases of marine operation, in particular the construction and function of the various types of Diamond Soot Blowers being described. The lecture is available to marine engineers, shipping and ship building concerns, and college and naval authorities, on application to the home office of the company at Detroit.

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TRADE PUBLICATIONS

Steam Hoists.—The Lidgerwood Manufacturing Company, 96 Liberty street, New York City, has issued a catalogue describing steam-hoisting engines for contractors' uses. Specifications and details of construction are given for engines to be used for derricks, pile drivers, coal hoisting, dredge work and the like.

Reading Wrought Iron Pipes.—This new catalogue of the Reading Iron Company, Reading, Pa., contains a brief history of the iron industry from the time the metal was first discovered down to the present. In addition to this, a complete description accompanied by illustrations is given of the modern processes as carried out by the Reading Iron Company.

Plymouth Rope and Cordage.—The general catalogue issued by the Plymouth Cordage Company brings together in convenient form for reference such information as will make clear to buyers the distinguishing characteristics of the different kinds of Plymouth cordage, and will enable them to secure the kinds best adapted to their various needs.

American Ingot Iron Wire.—The Page Steel & Wire Company, 30 Church Street, New York, has recently issued a pamphlet which presents in convenient form data and tables pertaining to the properties of American Ingot Iron Wire. This information is of interest to engineers, superintendents, and purchasing agents, and to the wire industry in gentral.

Data Book for Engineers.—The Locomotive Superheater Company, 30 Church street, New York City, has issued a convenient pocket size data book for the use of practical operating engineers. The uses of superheated steam in boilers is discussed in the introductory pages and the remainder contains tables and general information useful in the operation of a power plant.

Industrial Uses of Superheated Steam.—This is a reprinted pamphlet by the Power Specialty Company, 111 Broadway, New York. The original paper was read before the American Society of Heating and Ventilating Engineers. The various uses of superheated steam are stated and illustrated, and there are also a number of calculations of heat transfer and steam saving accomplished by it.

Defend Your Steam.—Under this title the Magnesia Association of America has issued a booklet discussing the problems of pipe and boiler insulation. The aim of this book is to furnish the key to some of the problems confronting the architect, engineer and owner in the conservation of fuel by the provision of adequate protection for the steam pipes, valves, boilers, and other heated surfaces against heat losses.

Feed Water Heating.—A pamphlet recently sent out by the Griscom-Russell Company, 90 West Street, New York, reviews the advantages of feed water heating and gives a general description of the device known as the Reilly Water Heater, produced by this company. Complete specifications for various types and sizes of the heater are given, together with instructions for determining the proper equipment for any given boiler installation.

Synchronous Condensers.—A bulletin superseding all previous data from the General Electric Company, Schenectady, N. Y., on the subject of synchronous condensers has been issued quite recently. The data contained covers the subject both of power-factor correction and power-factor control, through synchronous condensers. Calculations for the use of the condensers in each connection are given, with several calculations for correction and control.

Locomotive Shops.—Dwight P. Robinson & Company, New York, consolidated with Westinghouse, Church, Kerr & Company, has issued a folder containing thirteen photographs of the Baltimore & Ohio locomotive shops at Glenwood, Pa., and Cumberland, Md., built by Westinghouse, Church, Kerr & Company.

Marine Efficiency Devices.—Among the new devices of the McNab Company, Bridgeport, Conn., combustion indicators, frigidometers, salt detectors, stern tube appliances and torsion meters are described in a catalogue sent out by this company. Complete instructions and calculations when necessary adequately to illustrate the use of the various appliances are given in detail, as well as illustrations and explanations in connection with the devices.

The Story of Gasoline.—In a 40-page pamphlet issued by the Atlantic Refining Company, Philadelphia, many useful and interesting facts concerning the properties of gasoline have been presented in an attractive manner. A chapter on carburization discusses the effect on efficiency and power brought about by variations in the gas mixture. Six pages at the end of the booklet are devoted to a classified list of engine troubles with the remedies.

Prudential Steel Building.—The Blaw-Knox Company, Pittsburgh, Pa., has issued a 32-page catalogue illustrating and describing the line of portable steel buildings manufactured by that company. There are photographs and short accounts of the use of these buildings for a number of different purposes, including labor camps, field offices, watchmen's shanties, industrial buildings, etc. The catalogue also has general plans for various standard structures.

Capstans.—The uses for capstans on board ship are numerous, and the American Engineering Company, Philadelphia, Pa., goes into details on this subject in a catalogue recently issued. Descriptions of steam-driven capstans and gypsey heads, dock capstans, and electric- and hand-driven machines are given in addition to the standard types illustrated. The company announces that special types will be built to any required specifications.

Uehling Instrument Company, 71 Broadway, New York City, exhibited fuel saving devices at two of the leading expositions of the year—the Chemical Show, Grand Central Palace, New York, September 20-25, and the National Association of Stationary Engineers' Convention, Milwaukee, Wis., September 13-17. The principal devices displayed were the new style "U" CO_2 recording equipment, together with Uehling pyrometers and draft gages.

NEW INCORPORATIONS

The following incorporations of maritime interest have been reported in the last month:

American Shipping Agency, Inc., Wilmington, to own and operate boats, $100,000.

American Transatlantic Lloyd, Inc., Wilmington, to own and operate boats, $7,000,000.

Adam Steamship & Commerce Corp., Jersey City, $50,000; H. J. Skinner, Alfred F. McCabe.

Ocean Pearl Products Corp., Manhattan, $50,000; F. Herbek, F. R. Fischer, J. Vrana, Astoria.

Emerald Motorship Co., Delaware, $3,000,000; T. L. Croteau, M. A. Bruce, S. E. Dill, Wilmington.

Jamaica Bay Dock Corp., Manhattan, $98,000; R. L. and R. H. Baldwin, J. H. Ward, Ridgewood.

Wallington, Gibson Co., shipping, $50,000; Martin E. Smith, Artemas Smith, A. E. Wallace, Wilmington.

The Calvert Navigation Co., Wilmington—To own and operate boats; incorporators not named, $1,000,000.

Vincent J. Ajello, Manhattan, ship broker, $10,000; A. H. Strickland, J. Potts, V. J. Ajello, 15 William street.

Disappearing Propeller Boat Corp. of New York, Buffalo, $600,000; W. L. Marcy, L. R. Gulick, W. V. Moot, Buffalo.

Baltimore-New York Ship Service Corp., 77 River street, Hoboken—Build ships, vessels, engines, etc., capital, $500,000.

Black Star Steamship Co., Jersey City, $500,000; Samuel B. Howard, Robert K. Thistle, A. Roy Myers, New York.

Dominican Steamship Co., Delaware, $300,000; August E. M. Thiery, Raymond E. Cook, John F. Wharton, New York.

American Commerce Freighting Corp., Wilmington, to conduct a general shipping and lighterage business, $100,000.

Aetna Steamship Corp., Manhattan, $100,000; F. E. Rowland, C. Muller, E. J. Atkinson, 1242 Herkimer St., Brooklyn.

Maurice River Packing Co., Camden, N. J., engage in fishing. $300,000: Edward Burke, Marcus Shop, Matthew Jack, Camden.

Frank J. Alexander, Manhattan, trucking and stevedore, $10,000; F. J. Alexander, F. D. Lewis, J. Dietsch, 459 11th avenue.

Overseas Despatch, Manhattan, steamship and railroad tickets, $10,000; C. F. Spamer, D. Somogvii, J. A. Berko, 140 East 85th St.

De Parrie Co., Manhattan, ship, hotel and club supplies, $7,500; W. Irvine, J. H. Strange, O. J. De Parrie, 166 13th Avenue.

Savannah Coal Dock Company, Delaware, $600,000; Samuel B. Howard, Raymond J. Gorman and Robert K. Thistle, New York.

Wright Engineering and Construction Co., Wilmington, Del., $500,000, dock construction, highway location and construction work.

National Ship Supply and Machinery Co., Manhattan, build vessels, $50,000; Charles Sheer, Elizabeth A. Ikam, L. Algase, New York.

Merchant Marine Corp., Newark, $125,000, to build steamships; J. F. Hefernan, B. F. Hefernan, Elizabeth; G. H. Schwartz, New York.

American Transportation Service, Manhattan, stevedoring, $50,000; T. V. Malley, J. Skelling, J. R. Gatchell, 104 88th street, Brooklyn.

American Transportation and Trading Corp., Delaware, $20,000,000; steamships, &c., T. L. Croteau, M. A. Bruce, S. E. Dill, Wilmington.

Immigrant Transportation Bureau, Manhattan, steamship tickets, $10,000; L. Unterman, J. Yedin, L. Schiff, 836 Bushwick avenue, Brooklyn.

Mt. Washington Steamship Co., Wilmington, operate boats, etc., $500,000; George E. Bengle, Robert E. Ammin, Frank M. Gervodette, New York.

Overseas Despatch, Manhattan, steamship and railroads tickets and forwarding, $10,000; J. A. Berko, D. Somogyl, C. F. Spamer, 30 Walcott street, Brooklyn.

Tacony Riverton Ferry Co., Riverton, N. J., operate ferry between Burlington County and Philadelphia, $250,000; Casper M. Titus, Tacony; George T. Sale, C. Warren Allen, Frankford.

Designations

General American Line, Del., 5,000 shares preferred stock, $100 each; 20,000 Class A, common, $100 each; 15,000 common, Class B, no par value; rep., E. S. Napolis, 60 Wall St.

Ovens Tow Boat, Del., $1,000,000; rep., G. W. Ovens, 32 Broadway, New York.

A. Bagadin & Co., Del., steamships, 10,000 shares common stock, no par value; rep., S. B. Howard, 65 Cedar St.

Capital Increases

Todd Shipyards Corp., Manhattan, carry on business with $160,000 and 232 shares common stock, no par value.

American & Cuban Steamship Line, Manhattan, $25,000 to $1,500,000.

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Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIPS AND SHIPBUILDING

Barges, New Orleans, La.—Four 615-ton barges and six 750-ton barges will be built by the Doullutt & Williams Shipbuilding Company.

Tankers, Oakland, Cal.—It is reported that the Hanlon Dry Docks & Shipbuilding Company is negotiating for a contract for the production of several tankers.

Barges, Nashville, Tenn.—United States District Engineer has let contract for building 4 steel barges to Charles Ward Engineering Works, Charleston, W. Va., for $66,000.

Barges, Beaumont, Tex.—Three barges for the Mexican oil trade will be built by T. H. Trahey, of Seattle, at the yards of McBride & Law, Beaumont, Tex., which he recently leased.

Motorships, Seattle, Wash.—It is reported that W. L. Comyn, controlling owner of the Pacific Motorship Company, is negotiating for the purchase of four motorships from the J. E. Chilberg Company.

Tankers, Ottawa, Canada.—The new Government of Mexico has placed an order with the Prince Rupert Dry Dock Company of Ottawa, Can., for the construction of thirty-seven ships, mostly oil tankers.

Barges, Mobile, Ala.—The Henderson Shipbuilding Company, is building a 400-ton barge for its own account, and will soon begin building three more. The plant also has extensive repair contracts on hand.

Repairing Vessels, Seattle, Wash.—Five deep sea vessels, and two Puget Sound carriers are lined up at the Harbor Island Plant of the Todd Drydocks, Inc., for repairs aggregating an expenditure of $100,000.

Rebuilding Steamers, Seattle, Wash.—The Pacific Coast Engineering Company has secured the contract for converting the Japanese-built steamship Eastern Leader from a coal burner to an oil burner at a cost of $82,500.

Barges, Bath, Me—The Kelley, Spear Company, Bath, Me., has recently obtained contracts for building two ocean coal barges of 3,000 tons deadweight capacity each, for the Staples Transportation Company, Fall River, Mass.

Steamers Bought, New York.—The Green Star Steamship Corporation, 115 Broadway, has purchased four 9,550-ton vessels from the G. M. Standifer Construction Corporation, Seattle, Wash., for about $165 per deadweight ton.

To Build Steamer, San Francisco, Cal.—J. D. Spreckels, president of the Oceanic Steamship Company, San Francisco, has stated his company plans to build a steamer for the Australian-San Francisco passenger service to replace the steamer Sierra.

Freighter, South Portland, Me.—Work is going ahead on the 1,200-ton freight steamer building in the yard of the P. H. Doyen Company, she being now partly planked in. She is being built for sale, and the builders expect to put her overboard early next spring.

Tankers, Wilmington, N. C.—A report that the Carolina Shipyard is building four freighters for builder's account was an error. The company is building two tankers for its own account, and two for the Eagle Oil Transport Co., Ltd.

Barges, Stockton, Me.—The Stockton Yard, Inc., has secured a contract to build two 98-foot barges having a capacity of 200 cords of wood for the Pejepscot Paper Company. It is rumored that a coasting schooner is also being built at Sandy Point for the same company.

To Build Six Tankers, Everett, Wash.—The Norway-Pacific Company has contracted to build six 12,000-ton deadweight tankers for unnamed Norwegian interests. The first keel will be laid soon, and the schedule calls for deliveries beginning in August, 1921, the last vessel to be completed in 1922.

To Build Ships, West New York, N. J.—The electric Steel Shipbuilding Corporation, has been incorporated in Delaware, with a capital stock of $600,000, by Frank Knoton, West New York; L. P. Sniffin, Yonkers, N. Y., and H. W. Jarvey, to build steel vessels of various types.

Steel Hull for Dredge, South Portland, Ore., has been leased by the Pacific Marine Iron Works for the construction of a new steel hull for the port of Portland dredge Columbia. Contract price for this dredge, including the renovation of machinery, is $425,000.

Tankers, Oakland, Cal.—A contract for the construction of six oil tankers for the Anglo-Saxon Petroleum Company, Ltd., London, was recently let to the Union Construction Company, Oakland, Cal., and the Southwestern Shipbuilding Company, San Pedro, Cal., each company having been given three to build.

Tugs and Equipment, New York.—The Dolphin Transportation Company, 15 Whitehall street, recently incorporated under the laws of New Jersey, has contracted for two 750-horsepower tugs, 100 feet long; one open lighter with 5-ton gasoline hoist; three covered barges; three dock lighters and one coal barge.

Reconditioning Steamer, Seattle, Wash.—Steven Birch, of New York, president of the Alaska Steamship Company, Seattle, Wash., has been asked to approve the expenditure of $300,000 for the overhauling and reconditioning of the steel steamship Victoria, now on her last voyage to Nome and St. Michael for the present year.

Programme Reduced, Japan—Directors of the Nippon Lusen Kaisha have decided to reduce their shipbuilding programme from 500,000 tons to 100,000 tons. All orders in Japan on which work has not been commenced will be postponed, and no new orders will be placed until the shipping situation shows improvement.

Tankers, San Francisco, Cal.—The Union plant of the Bethlehem Shipbuilding Corporation, was awarded a contract by the Standard Oil Company of California for the construction of three 15,000 deadweight ton tankers. Work will be started immediately, and it is anticipated that the first vessel will be ready by June, 1921.

Repairing Steamer, Oakland, Cal.,—The Moore Shipbuilding Company, was awarded a contract for repairing the Dutch steamer, Arakan, at a cost of $297,854. Repairs will include 109 bottom plates and 110 frame floors and reverse frames, and it will be necessary to remove the funnel, main engines, boilers and thrust shaft for realignment.

Repairing Tanker, San Francisco, Cal.—The Moore Shipbuilding Company was awarded the contract for repairing the Shipping Board tanker Imlay. The specifications called for changing the turbine to a reciprocating engine, and other minor repairs to the 10,000-ton oil carrier. Bids on the job ranged from $82,623, submitted by the Moore yards, to $128,710.

Contracts for Engines, New York.—Seabury & De Zafra, Inc., 150 Nassau street, have placed contracts for two 450 indicated horsepower fore and aft compound marine engines, with the John W. Sullivan Company, New York, and two 12-foot Scotch marine boilers with the Kingsford Foundry & Machine Works, Oswego, N. Y. They have also purchased two Skandia 240-horsepower fuel oil engines for Mexican interests.

Packing for Shipping Board Vessels.—The Shipping Board has awarded contracts for furnishing packing of various kinds to the Board's vessels at domestic ports for the year beginning October 15. The Anchor Packing Company and the United States Rubber Company, who were the successful bidders, will divide between them the entire purchase, amounting to about $2,000,000.

Buys Steel Vessel.—The North Atlantic & Western Steamship Company, operating from Boston to the Pacific Coast ports of Los Angeles, San Francisco, Portland and Seattle, has purchased from the Shipping Board the new steel steamer M. C. Brush, for $185 per ton. She is an oil burner of 7,825 deadweight tons, having a speed of 12 knots, and is 401 feet long, 54 feet beam, and 24.5 feet depth of hold.

Schooner, Camden, Me.—A four-masted schooner, of about 1,000 tons, will be launched October 28, at the R. L. Bean Shipyard. The vessel is principally owned by Camden people, but will be managed by Dunn & Elliot, of Thomaston, Me. The schooner is 200 feet length of keel, 41 feet beam and 21 feet deep, and will be named the T. M. Bransdall. The keel for a similar vessel will be laid as soon as the ways are clear.

Reconditioning Vessels, New York.—The Atlantic Transport liner Minnekahda has finished her last trip under the British flag. She will get American registry, and after reconditioning will be transferred to the American lines New York-Hamburg service. The steamer is a twin-screw of 17,000 gross tons, and is 600 feet long. When reconditioned she will have a passenger-carrying capacity in cabin and steerage of more than 3,000.

Motorships, New York.—It is reported that the Kerr interests, of which H. F. Kerr and Alfred E. Clegg, 17 Battery Place, are president and vice-president, respectively, plan the creation of a fleet of motorships. It is stated that they have been investigating the new Diesel engine evolved by the Bethlehem Shipbuilding Corporation, with the object of placing contracts for several freighters equipped with the new two-cycle internal combustion engine.

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Refrigerating Steamers, Elizabeth, N. J.—Two twin-screw refrigerator steamers are under construction at the Moore plant of the Bethlehem Shipbuilding Corporation, for the International Products Steamship Company, a subsidiary of the International Products Company, 120 Broadway, New York. The steamers are of the single deck type and built of steel throughout. They will have a length over all of 54 feet; beam, molded, 40 feet; depth, molded, 18 feet 7 inches; draft, loaded, 8 feet 6 inches.

New Company Buys Shipyard, Baltimore, Md.—The National Ship Supply and Machinery Company, of New York and Chicago, has bought the plant and contents of the old Maryland Shipyard and Supply Base at Soller's Point, Baltimore. The plant consists of 2,800 feet of waterfront and 25,000 feet of railroad siding, together with a large amount of machinery. The company has the following officers: President, Albert A. Rasher; vice-president, John F. Connell; treasurer, Fred Mayer; secretary, William Rosenfeld.

Keels of Battle Cruisers Laid.—The keels of the battle cruisers Constitution and United States have been laid at the Philadelphia Navy Yard. The cruisers will each be 874 feet long and have a tonnage of 43,000, the engines will be of 180,000 shaft horsepower, capable of developing a speed of at least 33 knots. Each vessel will have an armament of eight sixteen-inch guns. The keel for the Saratoga, another of these cruisers, of which there are six to be built for the Navy, was laid at the Camden yard of the New York Shipbuilding Corporation. The vessels will burn oil.

Oil Barges, Staten Island, N. Y.—A contract for the construction of four bulk oil barges for the Standard Oil Company of New York has been placed with the Staten Island Shipbuilding Company. The dimensions of each barge will be: Length of hull, molded, 150 feet; beam, molded, 27 feet; depth, molded 11 feet 6 inches; rise of bottom, 4 inches; pitch of deck, 4 inches. Each barge will be built to carry 250,000 gallons of oil for five tanks. They will be of car-float type, with deck house aft for crew, pump on the deck amidship, expansion trunks and complete equipment.

Composite Ships Sold, Cleveland, Ohio.—Under conditional arrangements, Louis M. Atha, of Cleveland, has agreed to purchase about ten composite vessels of from 3,500 to 4,000 deadweight tons from the Shipping Board for the sum of $140,000 cash each. An initial cash payment of $3,500 has been made on one ship, and upon personal inspection of the vessels Mr. Atha will take over one of the vessels, completing at that time the cash payment for the full amount. At that time he will also pay $31,500 additional to be applied at the rate of $3,500 each on the remaining nine ships. It is reported that Mr. Atha has negotiated for the sale of these vessels to foreign buyers.

New Type Freighters, Sparrow's Point, Md.—The four 20,000 deadweight ton ships to be built by the Bethlehem Steel Company are to be of a new type, carrying ore from Chile and fuel oil back. The ore bins will be run longitudinally through the center of the ship, being carried high up, as is usual in ore carriers to prevent excessive rolling. The space to both sides and below the ore bins will be double riveted, calked, and divided into tanks for the carrying. About 19,000 tons of ore will be carried on the north run, and approximately 130,000 barrels of oil back. The ships, which will have a speed of between 10½ and 11 knots an hour, will be driven by West heavy-oil internal-combustion engines similar to those that have given such good service on the Cubore, recently put into service by the company on the Cuban run. Twin screws will be used, and somewhat more than 6,000 horsepower will be developed. No passengers will be carried.

Additional contracts on hand will keep the yard busily employed well into the year 1922.

SHIPYARDS AND DRY DOCKS

Shipyard Addition, Oakland, Cal.—The Moore Shipbuilding Company, has filed plans for the erection of a power house.

Machine Shop Addition, East Boston, Mass.—The Simpson's Patent Dry Dock Company is building a 24 x 66 feet addition to its machine shop.

Increase of Capital, Philadelphia, Pa.—The Philadelphia Ship Repair Company, Mifflin Street Wharf, has increased its capital from $200,000 to $600,000.

Machine Shop Equipment, Etc., Beaumont, Tex.—The Beaumont Shipbuilding & Dry Dock Company will erect a machine shop and install equipment at its plant at an estimated cost of $100,000.

Repair Plant Resumes, Crisfield, Md.—The old Crisfield shipbuilding plant has been rebuilt and rearranged by Wallace M. Quinn, who recently purchased the property, and has resumed vessel repair work.

New Shipyard Plant, Frankfort, Ky.—The Frankfort Elevator Coal Company will establish a shipbuilding plant for building boats and barges. They have leased a building and will soon install machinery.

New Shipbuilding Company, Pawtucket, R. I.—The Mackinac Company was recently incorporated with a capital stock of $50,000 by Lowell Emerson, William K. Toole, and Archibald C. Matterson to build vessels, etc.

To Establish Plant, Jacksonville, Fla.—The Saliger Ship Salvaging Corporation, 542 West Twenty-third street, New York, has secured 300-foot waterfront site at Jacksonville, Fla., to establish a dry dock, repair and salvaging plant.

Dredging, Oakland, Cal.—The Moore Shipbuilding Company closed a contract with the American Dredging Company, of Oakland, Cal., for a six or eight months' job of excavating along the quay wall at the foot of Market street.

Floating Dry Dock, Sparrow's Point.—The last of the pontoons for the new floating dry dock of the Bethlehem Shipbuilding Corporation, Ltd., has arrived. It is expected that the dock will be ready for operation by the middle of December.

Shipyard Leased, New Bern, N. C.—The Newport Shipbuilding Corporation has leased the former shipyard of the Liberty Shipbuilding Company, Wilmington, N. C., recently taken over by the city. It plans for immediate operations.

Dry Dock, Clifton, L. I.—Another section of the new dry dock of the New York Harbor Dry Dock Corporation has been delivered to the company's plant at Clifton, L. I. When completed the dock will be capable of lifting a ship of 10,000 gross tons.

New Building Plant, Baltimore, Md.—The Marine Transportation Company, 908-10 So. Broadway, has been incorporated, with $450,000 capital stock, to build and repair vessels. The incorporators are Clarence B. and Arthur E. Gore and George H. Kastendike.

Shipyard Expansion, Pensacola, Fla.—The Bruce Drydock Company, has bought the property of the Deep Water Shipbuilding Company, which adjoins the Bruce Drydock waterfront, and will use the place for extensions of its present equipment.

Marine Railway, Wilmington, N. C.—The Stone Towing Company will construct a marine railway about 400 feet long with a cradle of from 250 to 300 feet, and estimated to cost about $60,000. The company will also erect machine and woodworking shops.

To Raise Steamer, New York.—The Saliger Ship Salvage Corporation, 542 West 23d St., has bought the wreck of the former Coast and Geodetic Survey ship, Isis, sunk off St. Augustine, Fla., and will attempt to raise and repair her. Methods invented by Mr. Saliger will be used.

Addition to Power Plant, Philadelphia, Pa.—The Wm. Cramp & Sons Ship & Engine Building Company, Richmond and Norris streets, has awarded a contract for a two-story 60- by 120-foot addition to its power plant to Fred A. Havens, 945 North Nineteenth street.

Bids for Shipyard, Savannah, Ga.—Bids were opened by the Shipping Board for the yard occupied by the National Shipbuilding & Drydock Company. J. W. Ridolph & Company, of Savannah, offered $70,000, and Harris Bros. & Company, of Chicago, made a bid of $40,000.

Shipyard Bids, Mobile, Ala.—The Shipping Board has opened bids on the shipyard formerly operated by Fred T. Ley & Company at Mobile, Ala. A. J. Stone, of Philadelphia, bid $181,705, the Alliance Equipment Company, of Mobile, $101,500, and William M. Turner, of Mobile, $110,025.

New Shipbuilding and Repair Company, Baltimore, Md.—The Marine Transport Corporation, 908-10 South Broadway, has been incorporated with a capital of $450,000 by Clarence B. Gore, Arthur E. Gore and George H. Kastendike, to construct and repair steamers, cargo vessels, etc. It is proposed to establish a local yard.

Shipyard Extension, North Cove, Conn.—Dauntless Shipyard, Inc., has let contract for constructing yacht basin, marine railway, storage sheds, locker building, also dredging in North Cove on Connecticut River, to T. A. Scott Co., Inc., 292 Pequot Avenue, New London, Conn., about $50,000.

Buying Shipyard, Hilton, N. C.—R. R. Stone, principal owner of the Stone Towing Company of Wilmington, N. C., announces that negotiations are nearly complete for his purchase of the property of the Suffolk Shipbuilding Company, on the Cape Fear River, just north of the city, at Hilton.

Floating Dock Finished, Baltimore, Md.—The Globe Shipbuilding & Dry Dock Company, which has assembled its big six-pontoon dock, has taken its first steamer out of water for repairs and painting. It was the Shipping Board steamer Corcoran, and was made ready for the workmen in forty minutes.

Marine Railway, Etc., Essex, Conn.—The Dauntless Shipyard, Inc., let contract for constructing a yacht basin, marine railway, storage sheds, locker building, also dredging in North Cove on Connecticut River, to T. A. Scott Company, Inc., 292 Pequot avenue, New London, Conn.; about $50,000.

New Company to Build Steel Ships, West New York, N. J.—The Electric Steel Shipbuilding Corporation, recently was incorporated in Delaware with a capital stock of $600,000, by Frank Knoton, West New York; L. P. Sniffin, Yonkers, N. Y., and H. W. Jarvey to build steel vessels of various types.

Shipbuilding Company Reorganized, Northport, L. I.—The Northport Shipbuilding Corporation has been dissolved and has been succeeded by the Northport Shipyards, Inc., organized with a capital stock of $100,000 by H. E. Bogdish, M. D. Flomenhaft and G. N. Dorney, 244 West 134th Street, New York.

New Shipyard Company, Bayside, L. I.—The Bayside Shipyard Company has been organized to provide winter storage and repairs for motor and sail boats. Thomas Runney, of the Siemund Electric Welding Company; John W. Ripley, of the Robins-Ripley Engineering Company; William H. Johns, of the George Batten Advertising Agency, and Robert B. Everett, are the officers of the concern.

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Buys Shipbuilding Plant, Pascagoula, Miss.—Announcement that the Kelly Shipbuilding & Dry Dock Company, Mobile, Ala., had purchased the plant of the International Shipbuilding Company, was made by E. A. Whitney, president of the Kelly concern. It is understood that the price paid for the plant is approximately $65,000 with the assumption of other obligations, although the machinery of the plant is said to have been valued at more than $250,000.

Shipyard Expansion, Eagle Island, N. C.—The Hamme Marine Railway Company, the marine repair plant of which J. F. Hamme, of Wilmington, N. C., is president, contemplate extensive improvements and additions to their yard. Plans include metal and woodworking shops, electrically operated machinery, an 800-ton marine railway to be constructed in two sections, 70 feet and 80 feet long to cost $30,000 to $40,000; there are 2,000 feet of docking space.

Shipyard Improvement, Clinton, Tex.—Extensive additions, including a floating shop fully equipped with machine shop, boiler making and blacksmith tools, joiner shop and other requirements for making repairs alongside vessels without interfering with loading and unloading activities, will be made to existing equipment in the yards at Clinton on the Houston Ship Canal, by Gray's Engineering Works, of Galveston, Tex. The company has established an office at Houston.

PORT IMPROVEMENTS

Dock, Pensacola, Fla.—The city let contract for building a municipal dock at a cost of $250,000 to the Pensacola Shipbuilding Company.

Wharves, Vicksburg, Miss.—The city proposes to repair and improve its wharves, landings, terminals, etc., at an estimated cost of $100,000.

Dock, Bellingham, Wash.—The city has decided to form a port district and to construct a large ocean dock in addition to rebuilding two piers at Blaine.

Freight Shed and Wharf, Portland, Me.—The Grand Trunk Railroad, India street, will build a one- and two-story 25- by 400-foot steel and timber freight shed and wharf.

Pier, Gulfport, Miss.—A municipal pier will be built here, with lumber derived from cutting timber on the site of the Centennial Exposition Company's proposed buildings.

Dredging.—The Belzoni (Miss.) Drainage Commission plans to redredge 112 miles of ditches, 14 foot bottom, 7 feet deep. S. Castleman, president; C. E. Miller, engineer.

Warehouse, New Orleans, La.—The Dock Board will build a huge warehouse for coffee and sisal storage, capable of accommodating the entire trade at the port in these commodities.

Wharves, Docks, Piers, Etc., Baltimore, Md.—William F. Broening, Mayor, Board of Awards, will vote on $2,500,000 bonds to acquire sites and construct wharves, docks, piers, bridges etc.

Wharf, Ottawa, Canada—The Department of Public Works let contract for repairing the wharf at St. Francois D'Orleans, Quebec, to S. Rattee, St. Ann de Beaupre. About $33,000 cost, plus percentage basis.

Coal Piers, Port Covington, Baltimore, Md.—The Western Maryland Railway, H. A. Lane, chief engineer, will expend $622,800 for extensive improvements, including the extensions to coal piers, dredging, etc.

Wharves, Etc., Manchester, Tex.—The city of ouston, Tex., will build two wharves and a coaling station, and remodel the cotton sheds, etc., at Manchester; $1,250,000 bonds will be voted. Address the Mayor.

Pier and Sheds, Portland, Ore.—Plans for the new pier and sheds at Terminal No. 4, are being perfected. These constitute part of the harbor improvements contemplated by the Dock Commission when they voted $2,000,000 bonds.

Pier and Transit Sheds, Vancouver, B. C.—The Harbor Commissioners, 712 Pender street, W., let contract for building reinforced concrete pier and transit sheds to the Northern Construction Company, Ltd., Carroll street; about $4,500,000.

Floating Dock, Etc., Montevideo, S. A.—Port works planned for Montevideo, Uruguay, S. A., include a floating dock, repair yard, deepening of the channel and several other improvements. This project involves the expenditure of about $34,000,000.

Harbor Development Manila, P. I.—At the last session of the Phillippine Legislature $6,000,000 was appropriated for improvement work in developing the harbor of Manila. The harbor will be dredged to a depth of 40 feet, and the present sea will be greatly extended.

Bulkhead, South Boston.—The Boston Molasses Company, 175 Milk street, Boston, Mass., let contract for building a reinforced concrete bulkhead on First street and Farragut Road to the Aberthaw Construction Company, 27 School street, Boston; about $50,000.

Improve Ship Channel, Etc., Houston, Tex.—The Harbor Board has recommended to the mayor that a $2,500,000 bond issue be made to cover the costs of additional improvements by the city on the ship channel and the Municipal Railway, and for the purchase of additional channel frontage by the city.

Ocean Terminal, Seattle, Wash.—Immediate construction of the west half of the superstructure at Pier B. Smith Cove Terminal, the largest commercial dock in the world, for the accommodation of transpacific passenger liners, has been assured by the purchase of $350,000 port of Seattle bonds by a combination of Seattle banks.

Big Terminal Project, Jacksonville, Fla.—The Jacksonville Port Development Company has been organized by a group of Florida business men for the purpose of acquiring terminal, warehouse and other facilities. E. S. Sharlow is president. It is also planned to buy, sell, build, repair and operate water carriers of all kinds.

Wharves, Auckland, N. Z.—The Harbor Board has been authorized to place a loan of $4,866,500 for the development of the harbor at Auckland. Plans are well under way for the completion of wharves and sheds, as well as the construction of three more wharves in order to meet the demands of the constantly increasing commerce.

Equipment for New Docks, Staten Island, N. Y.—In connection with harbor developments at Staten Island, the New York Harbor Commission, Murray Hulbert, Commissioner of Docks, will install mechanical equipment for freight handling, comprising cranes, monorail tracks and cars, elevators for motor truck transfer to different levels, hoisting machinery, etc.

Inland Waterway Improvement—Construction of the Illinois $2,000,000 waterway will soon begin. The project will extend from Lockport on the Desplaines River to La Salle on the Illinois River, a distance of 65 miles. It will connect 15,000 miles of improved waterways in the Mississippi Valley, and make continuous navigation possible between the Mississippi River and the Great Lakes.

Steamship Terminal and Equipment.—Plans for the proposed terminal of the Luckenbach Steamship Company, 44 Whitehall street, New York, on the New Jersey shore of the Hudson river, will include three piers, each 1,200 feet long, with sheds, warehouses, etc., and will cost about $10,000,000. Hoisting and conveying machinery, and other freight handling equipment will be installed at the terminals.

Dock, New Orleans, La.—Port Commissioners, let contract for erecting, painting and doing all steel work required on Poydras street shed, and extension of New Orleans dock, involving 240 tons of steel, to the Pensacola Shipbuilding Company, Blount Building, Pensacola, Fla., $39,600; side extension involving 110 tons steel to Alexander & Julian, 1104 Webster street, New Orleans, $22,320.

Pier Leased, Brooklyn, N. Y.—Announcement has been made that the Army Base, Pier 4, South Brooklyn, has been leased by the War Department to the Kerr Navigation Company, whose stock was recently acquired by the Harriman concern, the American Ship & Commerce Corporation. The pier is one of the finest on the Atlantic coast. It is 1,300 feet long, double-decked and equipped with every modern convenience.

SHIPPING DEVELOPMENTS

Increase of Capital, New York—The American & Cuban Steamship Line, 39 Cortlandt street, has increased its capital from $25,000 to $1,500,000.

Increase of Capital, New York—The Atlantic & Caribbean Steam Navigation Company, 82 Wall street, has increased its capital from $2,000,000 to $10,000,000.

Increase of Capital, Beaumont, Tex.—The capital stock of the Gulf Export & Transportation Company has been increased from $600,000 to $1,000,000 representing local investments.

Steamship Company Formed, New York—The Dominican Steamship Company has been formed by August E. M. Thiery, Raymond E. Cook and John F. Wharton, all of New York, with a capital of $300,000.

New Steamship Company, Baltimore, Md.—The West Indian Navigation Company, 3 East Lexington street, has been incorporated, with a capital of $100,000, by Frank E. Welsh, Jr., Richard E. Preece and Thomas H. Sanks.

Seattle-Oriental Service. Seattle, Wash.—The Shipping Board will put five passenger liners of 20,000 tons each on the Seattle-Oriental run, starting with the sailing of the steamship Wenatchee about January 1.

Portuguese-South American Service—The Portuguese State Maritime Transport Company will establish a permanent steamship service between Lisbon and Buenos Aires. The company owns a fleet of over forty vessels.

New Coastal Service, San Francisco, Cal.—The San Francisco & Portland Steamship Company will inaugurate a five-day service between San Francisco and Portland beginning November 1, it is announced by Frank Shafer, manager of the company.

New Steamship Line, New Bern, N. C.—The Elizabeth City Boat Line was recently incorporated with a capital of $50,000 by B. F. McHorney, president, and J. J. Harrison, secretary. The boats will operate between Baltimore, Norfolk and New Bern, N. C.

Steamer Sold, Gulfport, Miss.—The freight steamer Gaston, built of steel, 212 feet long, 847 tons gross, has been sold by the Baltimore Steam Packet Company to the Gulfport Fruit & Steamship Company, of Gulfport, Miss. The Spedden Shipbuilding Company is fitting the vessel for sea.

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Central American Line—Contracts for the establishment of the Central American Navigation Company have been signed by Eusebio Brenes Ortiz and officials of the Costa Rican Government, it is announced in advices from San Jose, Salvador. The company will operate vessels on both the Atlantic and Pacific coasts of Central America.

New Shipping Company, Charleston, S. C.—A new shipping company, recently formed, and is to be known as the Charleston Shipping Company, comprises the following officers: A. F. Pringle, president; H. F. Barkerding, vice-president; E. H. Pringle, Jr., treasurer. H. E. Quensted, secretary of the company, is in charge of the Charleston office.

Government Steamship Line, Chile, S. A.—A proposal is to be laid before the Chilean Congress for the creation of a Government-controlled steamship line. The proposed concern will maintain monthly sailings from Chilean ports to the United States and Europe. The plans provide for the immediate purchase of a 10,000-ton steamer.

Coast to Coast Service, Portland, Ore.—The announcement of the immediate inauguration of a regular three-week steamship service between Portland, Ore., and the ports of Philadelphia and Boston by vessels operating in the service of the North Atlantic & Western Steamship Company was made recently by officials of the Admiral Line, who act as agents for that company.

New African Service, Baltimore, Md.—A steamship line making regular trips to the Pacific Coast and to South and West Africa has been started by Page & Jones, Mobile, Ala., marking the entry of this port into this trade. The boats sail from Baltimore, making ports along the Atlantic Coast, touch Mobile, and then go through the Panama Canal to the Pacific.

New Steamer Line, Camden, N. J.—Two former Clyde steamships are to be run between Atlantic City and New York and to Philadelphia. They will be transferred to the new company now being formed, which will begin operations next spring. It is reported that the corporation is negotiating for two other steamships. The line will also narry freight. Warren Webster, of Camden, N. J., is interested in the new company.

Lake Steamship Combination, Chicago, Ill.—Negotiations for the sale of the Goodrich Transit Company to the Chicago, Racine and Milwaukee Line are pending. The combination, if effected, will make one of the largest steamship companies on the Great Lakes, and will dominate the lake trade of Chicago, Milwaukee, Detroit, Cleveland, Muskegon, Grand Haven, South Haven, Sturgeon Bay, Manitowoc and practically all ports on the shores of Lake Michigan.

Finland-New York Line—It is reported that a Finnish shipping company plans to establish regular steamship service between Finland and New York. The company has bought an ocean steamer, the Valtameri, which will make four trips a year each way and not call at intermediate ports. There will be accommodations for 100 passengers. It is expected the Finnish Government will grant subsidies to some extent for the enterprise.

Liner Purchased, New York—The ex-German liner Corcovada, rechristened the Guglielmo Pierce, has been added to the fleet of the Sicula Americana, 17 Battery Place, and will make her first trip under the Italian flag to New York some time in November, it is announced by Louis Costa, American representative of the company. The vessel has a displacement of about 21,000 tons, and has especially fine passenger accommodations.

Increasing Cuban Service—The Peninsular & Occidental Steamship Company announces that, in addition to the steamer Governor Cobb, which has been run under lease between Key West and Havana during the winter season, and will be put on a year-round run, the Cuba, now being completed at the Cramp shipyards, Philadelphia, will be ready for service about December 1. Both vessels are equipped for freight and passengers, and both are oil burners.

Shipbuilding Company to Operate Tankers, Baltimore, Md.—It is reported that interests in control of the Baltimore Dry Docks & Shipbuilding Company have formed a $2,000,000 corporation to be known as the Calvert Navigation Corporation to operate a fleet of four tankers which the company will build at its own plant. One of the tankers, the Clement C. Smith, was launched recently, and work on the other three vessels will be expedited. Holden A. Evans will be president of the new company.

Canadian East Indian Service—It is announced that the Canadian Government merchant marine intends to start a direct steamship service between Montreal and Indian ports, through an arrangement between the Government and the British India Company. It will be inaugurated with the sailing of the British India Company's vessel Boyne. The Government and the British India Company will each put four vessels on this route. The line will use Montreal in summer and Halifax, N. S., in winter.

Trinidad Line Bought—Furness, Withy & Company have bought the property and goodwill of the Trinidad Shipping and Trading Company and vessels of the Quebec Steamship Company. The Trinidad Company owns a large amount of property on Trinidad Island, and operates a passenger and freight service from New York under the name of the Trinidad Line, with offices at 29 Broadway. It is the intention of Furness, Withy & Company to continue to operate the three Trinidad ships under the name of the Trinidad Line.

GOVERNMENT BUSINESS

Refrigerating Equipment, San Diego, Cal.—Specification 4303, Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to install refrigerating machinery at San Diego, Cal.

Dredging, San Diego, Cal.—N. Smith, public works officer of the United States Navy, was authorized to expend $940,000 for dredging and filing in along sites of marine brigade post and naval training station.

Marine Railway, Hawaii, H. T.—Specification 4254, the Bureau of Yards and Docks, Navy Department, Washington, D. C., will receive bids until November 17 for completing the marine railway at Hawaii, H. T.

Jetties, Jacksonville, Fla.—United States Engineer, Masonic Temple, let contract to the Seaboard Dredging Company, for raising south jetties 3 feet above high-water level at a cost of $100,000. 15,000 tons of rock will be used.

Navy Yard Expansion, San Francisco, Cal.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., has completed plans for the erection of a new mechanical shop at the Mare Island Navy Yard, near San Francisco, Cal.

Steam Locomotive Crane—Specification 4263, Bureau of Yards and Docks, Navy Department, Washington, D. C., will soon receive bids for installing a 50-gross ton steam operated locomotive jib crane on the tracks at the Naval Dry Dock at South Boston, Mass. C. W. Sparks, chief engineer.

MARINE SOCIETIES

AMERICA

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Navy Department, Washington, D. C.

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NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS
29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE
Naval Academy, Annapolis, Md.

NATIONAL ASSOCIATION OF MASTERS, MATES AND PILOTS
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National Treasurer—A. B. Devlin, 187 Randolph Ave., Jersey City, N. J.
National Secretary—M. D. Tenniswood, 809 Vine St., Camden, N. J.

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Vice-President—E. H. Monroe, 902 Virginia Ave., Washington, D. C.
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National Secretary-Treasurer—Geo. A. Grubb, 311-315 Machinists' Building, 9th Street and Mt. Vernon Place N. W., Washington, D. C.

CANADA

GRAND COUNCIL, N. A. OF M. E. OF CANADA
Grand President—E. Read, Rooms 10-12, Jones Building, Vancouver, B. C.
Grand Vice-President—Jeffrey Roe, Levis, P. Q.
Grand Secretary-Treasurer—Neil J. Morrison, Box 886, St. John, N. B.
Grand Conductor—E. A. House, Box 333, Midland, Ont.
Grand Door Keeper—Lemuel Winchester, 306 Fitzroy Street, Charlottstown, P. E. I.
Grand Auditor—W. C. Woods, Toronto, Can.
Grand Auditor—J. C. Adams, 1704 Kitchner Street, Vancouver, B. C.

GREAT BRITAIN

INSTITUTION OF NAVAL ARCHITECTS
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND
39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS
Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORPORATED
The Minories, Tower Hill, London.

ITALY

COLLEGIO DEGLI INGEGNERI NAVALI E MECCANICI IN ITALIA,
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